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THE BEQUEST OF

ISAAC MYER

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THE PRINCIPLES OF ASTRONOMY.

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DREAMS OF MY SOLITUDE

ON THE

MYSTERIES OF THE HEAVENS

TREATING, AMONGST OTHER SUBJECTS,

UPON THE CAUSES OF MOTION; THE GOVERNMENT OF COMETS,
AND THE IMPORTANT PART ASSIGNED TO THESE AS
HERALDS OF LIFE TO THE WORLDS;
AND LASTLY, THE NATURAL OPERATIONS WHICH HAVE CREATED,
AND ARE STILL CREATING, THE UNIVERSE.

BY

JOSHUA PRUSOL.

As the book has been composed not with the purpose of teaching Astronomy, but of expounding the true principles on which that science should be based, it will be invaluable to young men just entering upon the deeper studies of the heavens. Through its homely style their imaginations will be led into new fields of thought more numerous than are to be found in any other modern work on Astronomy; besides, their receptive intellects being free from every taint of prejudice, can above all others best appreciate, at their true value, the momentous truths it is the humble aspiration of the Author to establish.

LONDON:
REEVES & TURNER, 196 STRAND.
1879.

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ERRATUM.

In page 136, before the first sentence of the second paragraph, insert as follows:—

The telescope undoubtedly has the power of enlarging to an equal degree every visible disc surface it is brought to bear upon, at whatever distance; but with the apparent smallness of the object its power of enlargement proportionately lessens. The moon, for instance, because of her proximity appears large, and thus powerful telescopes expand her into a glorious body, whereas if her position were as far from us as the sun she would be barely visible, and the same instruments would magnify her little above insignificance, and following up the rule, if placed as far out as Neptune, she would be invisible, and could only be revealed to view as one of the telescopic stars. We thus see that a body near at hand, &c. &c.

PREFACE.

THE views now first put together and published in this book are the fruit of meditations begun forty years ago, when the author, having emigrated to the southern hemisphere, was led by the nature of his pursuits to settle in the Australian Bush. Here he lived and spent the vigour of his days, isolated from the society of men with whom he could hold profitable intercourse, and all tidings, by means of literature, of what the rest of the world were about; and being thrown back in moody pensiveness upon himself and his own unaided powers of study and observation, he was drawn to commune silently with the starry hosts above, there so bright-eyed and fascinating, and to speculate thoughtfully on the powers that framed them, the laws that govern them, and the hand that guides their harmonious, yet mysterious, march. Here, as in leisure hours he brooded, thought after thought, by some to him inexplicable process, arose in his mind at intervals, and gradually took dark and uncertain shape in his dim conception, until each, as it threw light on the others, limned itself in clearer outline, and stood forth in a more rounded and bolder relief, and the whole began to assume the proportions of strictly reasoned and systematised conclusions, and to afford reasonable and satisfying explanations of much that was still obscure in the theory of both the heavens and the earth. These thoughts, even as compared with others in the same interest familiar to him before and since, he is weak enough to regard with greater and greater partiality; and as increasing years gave warning that the sunset of life was drawing near, the necessity was impressed upon him to give them utterance, if not for acceptance, then for rejection, at the hands of such as know better and may be more competent to give judgment upon them than himself. It is this duty he has striven to discharge here, and it has proved the most irksome and painful task he has ever had to go through with in the manifold and much-baffled battle of life—his humble talent for composition, from long disuse, having fallen rusty and feeble, and his desultory habits in the Bush having rendered it necessary he should coerce, or rather torture, himself from first to last into the application needed at every step in the work. It is a relief to him beyond expression that this task is now finished; and he hopes the manner of the execution, after the explanation given, will not be too severely criticised. His views, however faultily expressed, are, he is persuaded, clearly and fully stated; and such as they are, he offers them, not in the way of challenge, but that they may be fairly considered and sternly subjected to every speculative and scientific test. The author is too nearly related to the views propounded to judge of them with any finality of decision, and he leaves them therefore with those who can scan them with more judicial coolness, possess a wider range of vision, and can seize them with a firmer grasp. Dear, naturally, as these speculations are to him, the truth is dearer, and according as they consort or do not consort with it, does he expect others to give them entertainment, or undertake to renounce and repudiate them himself.

J. P.

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PRINCIPLES OF ASTRONOMY.

CHAPTER I.

WEIGHT AS APPLIED TO CELESTIAL BODIES.

THERE is nothing more familiar to a human being than weight. All things feel comparatively heavy, and this universal experience leads us to consider weight as a property inherent to matter, instead of being borrowed by it. So strong are our notions as to the natural ponderosity of matter, that we cannot think of it without implying heaviness. The word itself conveys the meaning, and the conception deepens as our thoughts rise from small to large objects, or bodies. An object comparatively small we often feel oppressively heavy, and we are therefore apt to conclude that all other objects or bodies are in the same degree light or heavy, according to their magnitude. A hill, we know, must be of great weight, and the heaviness of mountains and oceans is justly looked upon as tremendous, and that of the earth is unjustly put down as beyond conception.

Such are the ideas of weight held by civilised mankind, whether applied to earthly objects or heavenly bodies, and the greatest modern thinkers have pushed the ideas so far as to found upon them, in a certain sense, the government and safety of the Universe. Thinking of weight as a part of matter—which few can help doing, although science proves the contrary—it forcibly struck them, that as suns and planets float upon nothing, and being heavy beyond conception, to preserve them from falling into depth they must be endowed with some principle of support. They met the difficulty by the theory of centripetal and centrifugal force, and on this fickle principle they based the safety of all creation. In other words, if these two antagonistic forces ceased to act otherwise than they are supposed to do on all bodies—that is, if the one was the least stronger than the other, even to the weight of a grain of sand, and the disturbance of the balance to apply generally—it is freely argued, that the destruction of all bodies must necessarily follow: worlds would fly off wildly at their tangents through space; clash against each other, or drop into their suns; and that at least all secondary bodies would be annihilated.

However unanimous men of science may be as to centripetal and centrifugal forces being the dual preservers of creation, we may venture to suggest the more simple idea that the Creator has made the worlds so perfectly self-sustaining that they require no extraneous support. It will be our task, to the best of our ability, to demonstrate this truth on the abstract basis of there being no such thing as weight. Everything we lift, no doubt, feels more or less heavy, but the weight is not inherent in the object, or rather belongs not to it, but is due to some exterior action pulling it from us with a force equal to what we feel to be its weight. This outer force or forces, from which all things derive their weight, may be thus familiarised. My friend and I quarrel for the possession of some trifling article that either thinks himself entitled to. My position being overhead, he endeavours to pull it down from me; his dragging strength adds a weight to it almost beyond my strength, whilst the object itself, by the pulling attraction of the earth in opposition, is but a few ounces in weight. This example illustrates the true principle by which weight is imposed upon objects. All things have a certain weight, but it is only equal to the attraction that draws them, and were it not for this outside influence, or pulling force, ponderosity of matter would be unknown. Matter in itself has many qualities —it has shape, solidity, dimensions, and attraction; but there is in it no weight, and naturally it is as free from ponderosity as shadow. The great mountain is of enormous weight, at least millions of tons, but the weight is not in its own materials, but proceeds from the body of the earth on which it rests. The measure of its weight is just the attractive force of the earth's action upon it. If there was no attraction below, and the mountain were to be entirely free from any exterior influence, simple cohesion keeping it together, it would still be a large visible something, but as to weight an absolute nonentity. It would be so unresisting that a gentle breeze would waft it away, and carry it off like a shadow. Again, we might say that a house is of considerable weight, but let it only be freed from the attraction of the earth, and every brick, stone, and timber composing it would be absolutely nothing, in regard to heaviness. If under such circumstances it could but momentarily stand erect, without its parts fleeting away as a shadow, it would be so incapable of opposition that a man on horseback, galloping at full speed, with bandaged eyes, would pass through the structure without being aware that he was doing more than riding through vacancy. Finally, a strong man lifts a stone, say a foot square—he feels it to be an oppressive burden, but the weight, so trying to his strength, proceeds not from the stone itself, but from the invisible force pulling it down from him, with a degree of power exactly equal to its weight. In fact, when lifted up, there are, at the same instant, two opposing forces acting upon the stone, the attraction of the earth dragging it down, and the strength of the man's arms holding it up—and the measure of strength required to keep it from falling represents the exact weight imposed upon it as an object. If the block of stone could be freed from the attraction of the earth, it would be an object altogether devoid of weight, and would incline its course to the sun, the next greatest attracting force acting upon it. That the picture may be complete, let us suppose all material forces, as well as that of the earth, to cease acting, the stone in regard to weight would then be in the hand as an absolute nothing, without either leaning upon it or inclining in any other direction. Remove the hand from it, and there in empty space it would undoubtedly remain permanent and immobile, so long as it continued free from the action of attractive forces. The same reasoning, as in earthly objects, applies to heavenly bodies. Granted the idea that there is no weight in matter, it can be demonstrated on the soundest principles that any world, however large or small, taken not in parts, but as a whole, if put in a balance, would be as nothing, so far as it is in itself concerned. The power of exterior forces to impose weight upon independent bodies will be noticed hereafter.

The landscapes and scenery that diversify the surface of the earth, as one body, no doubt imply enormous gravitation, but it is the earth's action, as a whole, on its own materials that keeps them bound hard and firm together—the acting forces beginning on the outside, at all points, and concentrating at its centre—thus imposing weight on all parts, as they collectively act upon each other. The entire body, if lifted as a whole, has not a grain of weight. Weight in any body is impossible, except it be imposed by an exterior force. The weight of landscapes, seas, and mountains press heavily upon that portion of the globe where we are; if we go to the antipodes, we find the same thing; thus the weight imposed upon matter over every part of the vast surface, by meeting mutually, has a neutralising effect—inclining to or meeting at the common centre, the heart of the earth itself. A clod of earth is heavy, but its weight wholly proceeds from an exterior force. The same idea applies to the globe itself on a larger scale, for while its own attraction imposes weight on the materials of its surface, it is impossible that heaviness can belong to it as a body, except a force reaches it from some other body and imparts weight to it. The other body would have to be very near and much larger, to enable it to do so, and in the relative position of the earth on which we live, ten thousand times greater than the sun himself. No doubt, everything on the earth is heavy, but no part of the weight trends outwards. From every point it presses to the centre, and thus all the parts, whilst acting and reacting by attraction on each other, cannot add the least imaginable weight to the bulk. In fact, no body, from an object within the compass of the hand to a planet, can be heavy, except its weight be derived from another body, and whatever effect its own attraction may have in making its several parts feel heavy, it has no power to give this property to itself, as a whole. It is upon this principle—a total absence of weight—that the bodies of the universe float with perfect safety in vacancy. A thing without weight cannot fall!

Our primary idea on this point is, that matter in itself can have no weight, and applying the principle to the heavenly bodies, their government becomes plain and simple. They all have their magnitudes, shapes, solidity, and various other properties, but as to weight—as they are now constituted—none of them can be so powerfully acted upon. They hang in space, requiring no more support to save them from falling, than if they were simple shadows. They occupy—safe and immovable—the identical positions in which they were first formed. This last observation applies only to suns which do not move,* and never have moved the least imaginable distance out of the positions in which they were first suspended. Their part in creation is to control and govern smaller bodies, while they themselves are free from all control, the theories of great central suns and common centres of gravity notwithstanding. Secondary bodies in their courses are equally fixed, for they move on certain lines more or less circular, from which, if they are bodies of perfect mould, they can never deviate the thousandth part of a hair's-breadth, whatever the doctrine of disturbances may say to the contrary. These movements are not, as is commonly taught, necessary to hold them up, for, like all things that God has made, they are too perfect in themselves to require support. Suns which are supposed to be far heavier than planets derive no support from revolving motion, for they have none—much less then the bodies they govern, that are so much smaller. Still, in other respects, these motions are of vast utility in bestowing upon them their seasons and years.

It may reasonably be objected that while bodies in themselves are by nature light as shadow, they have weight equal to the strongest forces of attraction acting upon them in such a manner that they must fall into each other if not preserved by a presumed force or forces, termed centripetal and centrifugal. In other words, as regards our own system, the motive forces of the planets and the attraction of the sun acting in opposition with a perfect equality, they thus so act and react upon each other as to be in permanent safety. The revolutionary motions of bodies undoubtedly proceed indirectly from attraction or some unknown cause; but the forces which draw them round their orbits, as they are at present constituted, have no power to draw them nearer to what might be centres of destruction. As centres of gravity, either with or without their motions, they all enjoy the most perfect safety. A centre of gravity is therefore the key of the question, and being an all-important principle in the preservation of bodies, may be thus defined :—

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* It is generally held as an unquestionable truth that suns move round common centres of gravity in subjection to the opposing attraction of the planets they govern, and that they are thus made to revolve round circles, wide or narrow according to the magnitude of the planets respectively opposed to them. The calculations of the returns of eclipses proving themselves always correct to a minute, should dissipate the idea that our sun at least has any revolving motion whatever, for no such phenomena could be foretold if he moved in the least out of his fixed position. All forecasts rest upon the basis of the sun being a fixed body, and as they are all true, his immobility is a mathematical certainty.

All bodies without weight are attractive centres, while all others, which from their smallness and gravitating tendency may be termed objects, if of the least possible weight, cannot be attractive centres; yet the great and small have forces of attraction in common according to their magnitude. If we lift a stone we feel it to be of a certain weight, and this property or quality is imposed upon it, since it has no inherent attraction in its bulk of matter so strong as that of the earth, reaching not only itself but all its parts. It cannot, therefore, as a body, possess a centre of gravity; for every atom composing it, instead of clinging inward, falls in obedience to a law of nature towards the centre, from whence proceeds the strongest attraction acting upon it. If the stone is thrown, it is actually governed, during the time that it is in the air, similarly to a planet or satellite, performing revolving motion under precisely the same guidance [*] as that which controls the movements of worlds. The stone returns to the earth, and any other object that is in the power of man to project, however large, would likewise return, by reason that even the largest of them are too small to be attractive centres. The same would be the fate of the moon, as well as all other celestial bodies, if gravity —which means weight—in any direction could be imposed upon them, as on the stone or other objects. But the celestial bodies are, one and all, large enough to be gravitating centres, and are thus surrounded by their protecting attractive spheres.

What is meant by an attractive sphere is the space round any planet, satellite, or sun, within which its attraction is stronger than any exterior attractive force within the same space. All celestial bodies, great or small, are surrounded with their respective spheres of attraction, in all cases narrow or expanded, according to their relations with other larger bodies and their magnitude. The sun, for instance, is the largest body we know of, and thus his attractive sphere includes the total of that expanse, taken in its broadest outlines, called the system, while the major planets, because of their relationship with so great a body, have their attractive spheres narrowed in at all points. Still their respective expanses of predominant attraction are, in turn, much wider than those of the minor planets, on account of their greater magnitude and distance. All these bodies, and indeed every other in the system, of a lower standard than the smallest that has been or can be discovered—excepting aerolites—are centres of attraction. Objects dropped above any of them, if inside their attractive spheres, would fall into them, and not gravitate in any other direction, simply because within such limits—as regards the lowest class of independent bodies, very narrow—their attractive forces are the strongest. Once bodies become large enough to be thus constituted, neither the attraction of the sun nor any other material force in the heavens have power to impose gravity upon them, for in every case all their own materials fall or are inclined to fall in a contrary direction to their own centre, and this feature is common to the whole. If the sun's attraction could only reach any body with a stronger force than that inherent in itself, its fate would be sealed. The weight imposed upon the whole body might not exceed a single grain, but that would be sufficient for a fatal result. It would descend at first slowly, but from accelerated gravitation it would soon bury itself and its materials in the embraces of the sun! Let the body be only large enough to be a centre of gravity, and consequently within a sphere of attraction more or less expanded, it is as safe as the sun himself, if not within an attractive sphere of secondary rule; but if it once becomes in any degree heavy, in the sense that we should regard a body put in the balance, it is acted upon by an attraction from without, stronger at the surface than that of its own, and at once succumbs to the body thus acting with the greatest force upon it, and quickly falls into it.

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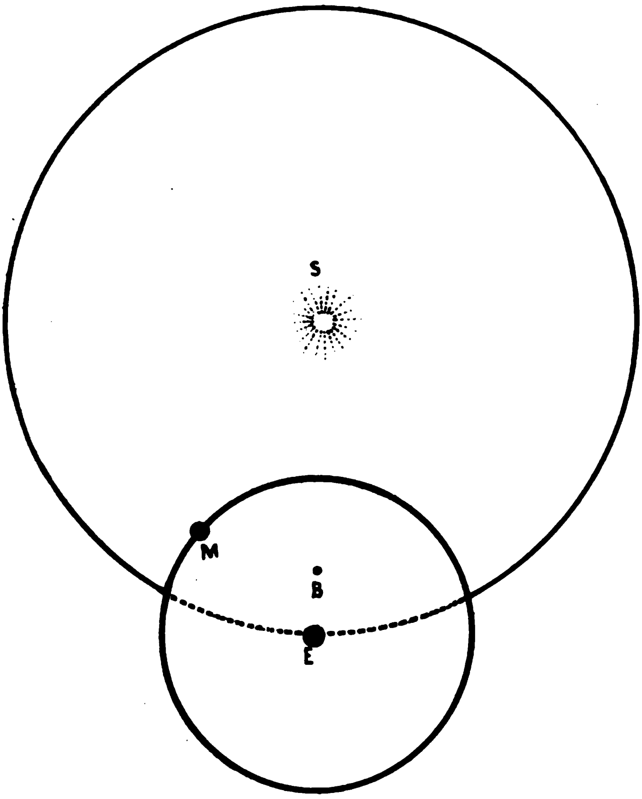
[*] If any object is thrown from the hand, it keeps pace during the time that it is in the air with the axial turning of the earth, instead of being left behind. By similar examples, the principles of revolving motion are explained in Chapter II.

The idea may be made clearer by taking S as the sun, E the earth, M the moon, and B a cannon ball shot up from the earth, and comparing the natural relations they hold to each other. B must gravitate back to E, for to whatever altitude the projecting force may send it, the attraction of E reaches its surface with a power stronger than that of its own as a separate body. No matter, therefore, what position in relation to the earth the cannon ball might be in, it could not be an attractive centre. Weight under any circumstances must belong to it, and hence it would gravitate back, instead of revolving round the earth as a satellite at the distance to which it is made to ascend, which it unquestionably would do, if large enough to be an attractive centre, or if the attraction belonging to it was stronger at its distance of projection than that of the earth. Again, if we compare the earth and sun, it is obvious that the attraction of the one is vastly stronger than that of the other, but as this force in all bodies decreases with distance, that of the sun in its action upon the earth becomes weaker than the attraction of the latter at its own surface. Consequently, while the power of the greater body governs the smaller, by imparting to it revolving motion, it can never impose gravity upon it or draw it nearer. Every particle of the earth—and all the parts make up the whole,—instead of falling to the sun, gravitate from him, in obedience to the stronger force acting upon them from the attractive centre to which they all belong. If a single grain of dust, as a part of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the earth, gravitated towards the sun, his power would be equal over the whole. Every particle of the body would be equally acted upon, and then, if it could be possible to put it, as a whole, in the balance, it would prove to be of a weight exactly equal to the pulling force of the sun upon it. The moon is powerfully acted upon both by the earth and sun, but even at her distance the terrestrial attraction is the strongest; otherwise she would go round the sun as an independent planet. As a dependant upon the earth, she is preserved in her lower state of subordination, by her attractive sphere, on the same principles by which the latter is preserved from dropping into the sun.

As everything herein submitted on the government of the heavens will be greatly based on the principle that all bodies large enough to be attractive centres are without weight, and therefore, incapable of resistance, without motive force, and self-supportive, it will be our excuse for once again referring to B in the diagram.

We before assumed it to be a ball, shot up from a gun, but we will now suppose it to be a body, in magnitude equal to a large hill, that rests upon the earth with great weight. The weight of course is not in the hill, but wholly proceeds from the gravitating strength of the whole body of the earth attracting it towards its centre. Imagine it to be lifted up some distance from the earth. It would still be inconceivably heavy, but the measure of its weight would be in exactly the same degree less as the earth's attraction becomes weaker by reason of the greater distance. At a still greater distance as a body, it would become lighter and lighter every step it would be raised higher, till at last at a certain altitude, the attraction of the earth upon it, balanced against the same force inherent in itself, would be so feeble that its total weight, millions of tons here at the surface, would become such that a man, Atlas-like, could carry it on his back. If, however, at this distance it were released, it would fall back again to the earth, for there would still be a weight, about equal to a man's strength, imposed upon it, by the terrestrial attraction. It might be removed still farther, so that it would weigh only an ounce or even a single grain, still that would be sufficient to subject it to the gravitating motion, and it would return to the earth from whence it was projected. Its position, however, is such that its own attraction as a body is still weaker, by a grain weight, than the strongest attraction acting on it from without; but that insignificancy is all-powerful to restore it to terrestrial embrace. Removed but a little more, and the last grain of gravity would be thrown off. Now, in its sufficiently remote position from the counterbalancing force of terrestrial attraction, it becomes, in itself, devoid of weight in any degree, floats in space as an independent body, and at once begins to revolve round the earth or sun, either as a planet or satellite, in obedience to the greater influence which the one or the other of these two bodies would have over it in its new position.

In being lifted from the earth, B would never arrive at safety, and this applies to all bodies, great or small, from a pebble to a world, were it not that the germ of self-protection in all situations is inherent, according to the measure of attraction belonging to it as a body. Wherever it may be, its own attraction is still the same, while that of the earth is weaker, till at last, insignificant by comparison though it be, the attraction native to itself is stronger on its own material than that of the earth or any other body, at the distance to which it has been removed. In other words, it becomes surrounded with its own attractive sphere, however limited that may be, and thus is a common centre in itself, drawing in all materials that may happen to be within its precincts, and performing the attributes of an independent self-supporting body. While it is subject to the government of some one particular body, the greatest body in the universe can no longer influence it by imposing upon it gravitation.

The example of the imaginary body B is in an equal degree applicable to bodies in every portion of space wherever they are, however large or small they may be. If they are only large enough to be in their positions centres of attraction, they can never fall or be drawn nearer to any other body, but will remain as independent as suns themselves. Their independence, however, must rest upon their positions in relation to other larger bodies. B, for instance, as observed above, would fall into the earth if in sufficiently close proximity, but would be as safe as the moon herself if at a certain remote position. In like manner there may exist hundreds of diminutive planetoids * or satellites, of a size so small as to be betwixt independent bodies and aerolites, which latter class all gravitate, and only exist for the short time they are falling into the bodies that exercise greater attraction upon them.

No truth can be clearer, or so easily demonstrated, than that the sun's attraction cannot reach a body in the system, however

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* For the sake of convenience, the liberty is taken in this work of dividing the heavenly bodies into six classes—namely, suns, planets, satellites, asteroids, planetoids, and aerolites. Each class diminishes in size in the order they are given. Suns, planets, and satellites, being so well known, require no illustration. Asteroids may be described as a class of very small planets, which, to our ideas, are below habitable size. A considerable number of the largest of the class have of late years been discovered between Mars and Jupiter—a space that should be mapped out in the system as the asteroidal zone. But however numerous the discovered asteroids may be within the same limits, it is likely there are a much greater number, invisible because of their smallness. We imagine there are very few asteroids in the system, except in that belt outside of which none have been as yet discovered. Planetoids, which there is strong reason to conclude, abound more or less plentifully in most latitudes of the system, all belong to the B class of bodies formed by natural operations, which we will endeavour to explain in the proper place. They are just built up to magnitudes that cause them to be attractive centres, and for a time remain in safety as the most insignificant of all independent bodies. Finally, aerolites are collections of matter, ranging from the smallest atoms to the largest that appear. The best definition that can be given of

small, aerolites excepted, with a strength equal to its attraction at and near its own surface. At a distance, more or less, his power surrounds them in all directions, leaving only little spheres of space, wide or narrow, according to their positions and magnitudes. Inside these expanses, or rather attractive spheres, they are all in a secondary degree absolutely dominant, and the power of the sun, at a safe distance, thus grasping them at all points, it may be argued that, without centripetal and centrifugal force, his attraction would draw them to destruction. Universal knowledge, however, proves the contrary, for there is no instance on record of his attraction having drawn any known body into himself, or indeed, a hair's-breadth nearer than the orbital line natural to it, if it be only large enough to be raised to the position of an attractive centre, while all objects below this standard, from the millions of aerolites constantly adding to the bulk of all bodies, to the thousands of objects we are familiar with on the earth, fall, without exception, into the sun and other bodies that may have the strongest hold upon them. If a stone is thrown, it actually rotates on an axis, and revolves with the motion of the earth the time that it is in the air, thus showing that during its career of momentary independence it obeys and is subject to the same government as the largest world. To make all complete, centripetal and centrifugal forces mutually act, or are supposed to act, upon it; yet it returns to the earth notwithstanding, while the planets and satellites never gravitate, simply because they are large enough to be centres of gravity, and to surround themselves with spheres of rule, within which their attractive forces are stronger than that of the sun or any other body. The objection may be made, that in the case of a stone, or any other object thrown from the earth, the forces cannot instantly counterbalance, and come into harmony, during the short time they are in the air, whereas, if they could only be made to remain up a sufficient time to allow the two forces to adjust themselves, they would continue to revolve

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them is, that the largest are planetoids, partially formed and not yet increased to the measure of safety by becoming centres of attraction. Wherever they may be, they are only gravitating bodies.

It may be observed of the six classes of bodies that the three first, suns, planets, and satellites, are, on account of their magnitude, visible if at reasonable distance. Asteroids, except a few that rank above what is meant by the term as a "general class," are invisible. Planetoids, although we suppose they must exist in great number, are never seen—unless some of the largest meteors history records have been such; and aerolites are likewise never visible as white incandescent bodies, but we know of their existence by the fiery tracks they leave behind them when they strike the atmosphere. The lowest order of bodies are ephemeral, and only exist whilst they are gravitating to those that attract them. The two classes above them, during the time they may be permitted to exist, which very rarely can be less than thousands of years, are perfectly independent, but yet it is their fate, at one time or another, to fall into the large planets over whose tracks they revolve. They are thus led into them not by the force of attraction, but by reason of their orbital motions intersecting the paths of the planets that eventually lay hold of them.

as satellites, and not again return to mother earth.* We can however refer to other small objects that remain floating through space perhaps for years, yet in the face of opinions to the contrary, we hold that they are all falling or gravitating bodies. Aerolites are the objects referred to, which in the aggregate descend in millions annually upon the earth. They are minute bodies, or small collections of matter, that undoubtedly originate within the system, and wherever they may be formed, they, as, gravitating objects, at once begin to proceed sunward. It so happens that drops of this universal shower, continually falling to the great centre, come in contact with the sphere of the earth's rule, in which case they are caught and at once turned in the new direction of the terrestrial centre. When they are first grasped within the sway of our planet, they may be at a distance of perhaps three or four hundred thousand miles, more or less, according to the expanse of our attractive sphere. From the instant they are caught, and throughout, they are falling bodies, but at the extreme distance terrestrial attraction being in great part neutralised by that of the sun, their downward course must be slow. During the gravitation, be it long or short, they are in a satellised state, performing their revolutions, and this continues till they one and all become incorporated with the earth, none of the millions setting themselves on fixed orbits, or remaining permanent as satellites. Yet they may have been for years acted upon in connection with one or other of the two bodies, by the above imaginary forces—forces which are put down by modern thinkers as the guardian powers that preserve the whole of God's creation.

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* The argument should be of value in raising the question, has the Almighty placed the existence of His boundless creation on so fickle a basis as centripetal and centrifugal force? For generations past, the most illustrious men—the shining lights of the world—have unanimously admitted that these supposed forces are so unstable, that the weight of a grain of sand, turning the balance either way, would consign all bodies into their suns, or else hurl them into infinitude. But as no planets have ever yet been known to descend upon their suns, or wander from their orbits into the unknown, we are justified in the broad conclusion that they owe their preservation to other principles sublimely simple, which may be briefly expressed in the assertion that they are so perfect in themselves as to require no support.

CHAPTER II.

ORBITAL MOTION.

THUS far we have tried to demonstrate that matter primarily in itself is as free from weight as spirit or shadow, and that its absence holds good in relation to all bodies, taken not by parts but as wholes, which are large enough to be attractive centres. The conclusions to be submitted on their government, whatever they may be worth, will be based upon this principle. If the idea of no weight or ponderosity—and consequently resistance—in the heavenly bodies is erroneous, the structure built upon it must be the same; but whether true or false, it will be our all-important foundation for the elucidation of the various motions of the system—the causes which keep and continue them at work, and at the beginning caused their origination. The basis may be rotten, and the principle we submit of non-resistance ludicrously false, but the task itself—freed from scientific difficulties—will be a very easy and simple one; for the facts as brought out will in every step be supported by the evidence of all discovered bodies.

If we wish to comprehend the forces which guide and keep the planets in motion, we must cast aside every theoretical idea, and be in the truest sense of the word practically prepared to believe in the evidence of our senses, and have unshaken confidence in that which we see. Bearing these facts in mind, if we take, in the first instance, the solar system, and study it minutely, together with the complication of its parts, we, by careful examination, will soon discover that in nearly every respect it is worked on the same principles as a machine set up by human hands. The machine, generally speaking, is not hard to master, either in its intricacies or the force or forces which keep it in motion; and the solar machine, if broadly studied in the same light, will be found to be as easy and indeed easier understood. True, its mechanism and various parts are joined together with a more perfect and God-like simplicity, and there is also this difference between the two—the human machine is microscopic, and so is the other, compared to the universe, but still in magnitude it extends in breadth no less than six thousand million miles, and its various parts are made up of above a hundred worlds. We will now examine the different parts of this great celestial machine—so much excelling in grandeur any human construction—view its motions, and explain the forces that control them.

The first feature of the celestial system which strikes the eye is a huge body in its centre. This body so far exceeds the other parts in magnitude, that, known or unknown, however numerous, if they were all deducted from it, there would be no sensible diminution in its bulk; unlike the others, this immense body, called the sun, remains fixed and immovable in its place. Most likely he has remained in the same identical speck of infinity without ever having moved a hair's-breadth, right or left, since his first formation. But it is not only the magnitude of this body that strikes us with such great force; there is also his glorious brilliancy, which fills the immense expanse of the machine with heavenly light, eclipsing the whole array of his subject-worlds, and making them appear as opaque objects and insignificant in comparison. The sun thus proves itself the ruler over all the parts so far as light and life are concerned, and how or why he has the command in other respects, remains to be seen.

The next leading feature in the machine is, that some of the parts visibly appear isolated—although all, great and small, are joined together by invisible bonds—one part is double, the earth and moon; while other parts are collected into groups or clusters in connection with the great planets, and, allowing for magnitude, increase in number as we recede from the sun. This is the case as regards the three nearest major planets. The most distant one, so far as yet known—although the third largest planet—is another isolated member of the great machine; but it may be that the telescope is powerless to reveal attendant lunar bodies at such a distance.

Another characteristic of the celestial machine is, that we find—so far as discovery can enlighten us—all its parts, or rather worlds, possessed of rotatory motion. This motion, as appertaining to the several bodies, is in every possible direction, according as the primal impulses may at the beginning have acted upon them severally. Some we find rotate differing not widely from west to east, and one, Uranus, from east to west,* others in the direction of north to south, or south to north, and considering the small number at any other angles of inclination, according to the manner the primal impulses acted in first imparting this motion to them respectively. Their rates of rotation are also, in an equal degree, arbitrary, and that quite irrespective of their distance from the sun or from each other. These motions in the Earth, Mars, and Venus are different, but, by a curious coincidence, not widely in their diurnal times; while Jupiter and Saturn, although farther from the sun, rotate in less than half the time. Uranus, again, judging from the rapid revolution of his moons, has a very quick rotation, which may be slower than the other two great bodies—but evidently exceeding that of the minor planets. A common effect, therefore, not being produced in the rotatory rates and directions of the planets, as compared with each other, it follows that while in every other respect they are subject to the central moving power, or, as we may term it, the heart of the machine, in this one particular they are not in the least degree influenced by the sun or any other body. Each one would perform its rotation just the same whether near or remote from the sun—whether mixed up in close proximity in clusters with similar bodies, or in remote lonely positions by themselves; and this for the very sufficient reason that these motions, which most likely belong to all bodies, are forces inherent in themselves, and can, therefore, in no way be influenced by the attraction and government of the sun, or any other exterior forces acting upon them.

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* The rotation of Uranus has not yet been discovered, but the motions of his moons round him are from east to west, and this no doubt indicates the rotatory direction of the planet as clearly as though we could see it with our eyes, for subject bodies universally, whether planets or satellites, revolve in the same direction as their governing bodies rotate.

It is totally different with revolving motion, which is, if not the grandest, at least the most wonderful feature of the great machine. Thus we behold all the bodies or parts of the machine rolling round the grand immobile luminary in the centre with great rapidity, their movements being on, or nearly on, the plane of his equator, and in one uniform direction, from west to east. Their motions, likewise, are uniform, or, in other words, they decrease in rapidity at so even a rate, according to their distance from the sun, that we have only to measure the arc of space any one of them moves over in a given time to know its distance; and it is by a like process that we can tell how far off a newly-discovered planet may be. It is superfluous to add, that it is the influence of the sun which produces all these harmonious and uniform effects—it is through him that they go round their orbits—facts all are agreed upon; it is also through him that they lie on the same plane with his equator, and by his guiding power they are led round their orbits in one uniform direction. Thus cause and effect working harmoniously together exhibit his wonderful power acting upon his subject bodies on the exact principles of human engineering, causing them to move all in common in one direction, and without this as yet unexplained acting power of the sun upon them, they would perform these revolutions in any arbitrary directions—just the same as in their axial motions—the only movements of the machine over which the sun has no control.

All the planets and satellites perform their periodical journeys not in circles, but upon orbits more or less approaching to such figures. If any orbit in the system is a perfect circle, which is very doubtful, the sun's position is in its centre; but if not a circle,,so far as the known movements of planets are concerned, it is oblong, in which case the sun lies nearer one end of the figure, and according to the difference the oblong varies from the circle, the sun's position is exactly in the same degree farther from its centre. This is a law that holds good in relation to all known orbits. Most likely it is universal; but how it is that governing bodies refuse to hold a central position within the orbits they govern, is one of the many secrets of science still unrevealed; and yet, as will be shown in the concluding chapters, these deviations from the circle perform a useful and most important part in planetary formation—a work, few are aware, which is still going on.

We suppose, however, that orbital figures, not being perfect circles, may be accounted for from the shapes of the bodies which describe them. The idea is submitted with extreme reserve, observation in the past not having been directed to the point, but if it be true, the line drawn round any body of perfect mould,* passing over both its poles, would present the same or nearly the same figure as that of the orbit it describes. A body truly spherical would, therefore, describe a circle; a spheroid would go round an orbit oblong in the same degree as the body describing it differed from the sphere, while a conical-shaped body, a comet, for instance, would describe an orbit in like manner of conical form. The orbit of the earth, to a small extent, establishes this fact, as a line drawn round both its poles would exhibit, if not the same figure as its orbit, one deviating but little from it; but whether or not the two figures do in shape exactly coincide, we are in possession of no precise facts to determine. Again, Jupiter and Saturn, the only two other planets we can reason from, are still more spheroidal than the earth; and their orbits, compared with that of the latter, vary from the circle in about the same degree. When we view these examples, together with the important fact, that, as far as can be traced, the orbits of comets present a very suspicious appearance, that, like themselves, these are of a conical shape, we are almost inclined to conclude that the true cause of the eccentricity of orbits might be thus accounted for, were it not that we have the crushing example of the moon, which, as far as we know, is not included in the list of spheroidal bodies, and yet her orbit round the earth is by no means a circle. Viewing the question, therefore, as a whole, while we firmly believe in the idea, it must be put down to a certain extent as hypothetical—that is, some convincing facts go to prove it, but they are too limited and vague to establish it as an unquestionable finality.

Having finished describing in detail the parts of the machine constructed by creative wisdom, it now remains to point out the forces that keep it at work. That our conception upon this may be clearer, we must especially keep in view the fact that all the planets roll round in a direction from west to east, and that their positions are on, or nearly on, the equatorial plane of the sun. Turning to the sun, we find that although he remains fixed, and never moves out of the same place, yet HE TURNS ROUND ON AN AXIS, a motion that we suppose is common to all bodies; but mark what follows, for if true, it is the solution of the orbital motions of all bodies—the axial motion of the sun is in the exact direction in which all his planets revolve round him. He revolves once in twenty-five days, so that turning motion constitutes the sun as the great central wheel of the machine that sets and keeps all his subject worlds in action, and imparts those motions—common to them all—that have so long been the wonder of man.

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* From the nature of the subjects we have to handle we cannot help giving frequent expression to enigmatical ideas, the meaning of which, whatever may be their value, will be more intelligible as the work progresses.

The comparison between the divine and human machines presents this remarkable resemblance, that great central wheels work them respectively, that the parts of both are all conjoined to the central forces, the one by visible and the other by invisible bonds, and that they each impart, by the turning round of their wheels, life and motion throughout. The comparison, however, holds good only so long as they continue to turn. When the governing wheel of the man-made machine stands still, all its relative parts are instantly at rest; and it is unquestionable that, if the mighty solar wheel could be made to cease turning, all the worlds subject to it would then and there likewise be at rest. They would remain permanently fixed in their places, and not tumble headlong into the unknown, as is generally taught. There can be no truth clearer than that they have their orbital motions imparted to them by the rotation of the sun, and these movements bestow upon them their seasons and years, but they contribute in no respect to holding them up. The sun himself has no such motion, yet, although he is accounted infinitely heavier, he hangs or floats tranquilly in the identical position creation first placed him. It is the same, no doubt, with all other bodies, whether quiescent or in motion, for Omnipotent Wisdom imparted such perfection to all His works that they can neither be disturbed, nor require holding up.

But, to revert to our comparison of the workings of the divine and human machines, it may be observed that the movements of the latter correspond to the rapidity of the great central wheel. If the governing wheel turns slow, all the parts move as they are acted upon, and at the same proportionate rate; but if the moving power is rapid, rapidity in an equal degree is imparted to all parts of the machine. The sun, as a wheel, for ever turns at the same uniform rate, so that we have no experience of the consequences of a change in his axial rate, but, if subjected to an acceleration or retardation of speed, the action on the parts of his machine would be precisely the same. Thus the great wheel, which is the sun, turns round once in twenty-five days, and with the exception of our moon, and the exterior satellite * of Saturn, it is the slowest rotatory motion yet

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* In no one instance have the rotatory rates of Saturn's moons been

discovered. If the sun's rotation had been of average rapidity, say once in twenty-four hours, all the planets would move round him at twenty-five times the speed they actually do, and, consequently, their years and seasons would be in the same degree shorter. Our year would consist of not more than fifteen days, while the years of the most distant planets, according to our ideas, would be of moderate duration. Again, had the solar rotation been as rapid as the same motions of Jupiter and Saturn, which at the beginning was just as likely as the very slow rotation he is endowed with, our terrestrial year would be less than a week. From these comparisons it follows that the years and seasons of our planets would indeed have been far different were it not for the sluggish rotation of the sun which rules over them; and as suns in general may reasonably be supposed to have rotatory rates on the average equal to the planets in our system, it follows that the revolving motion we are accustomed to, however wonderful it may be, is likely to be vastly more rapid in the majority of other solar systems. Taking rotation as the wheel or wheels that guide the motions of the universe, no other conclusion is possible. We cannot at will traverse through space to practically demonstrate its truth; but yet we are not without proof, for if we turn to the examples of the secondary systems of Jupiter and Saturn, the motions of their subject moons give us the most conclusive evidence upon the subject. No other bodies we know of have more rapid rotations, and in both cases their satellites, according to the distances they occupy, revolve round them with an equal degree of rapidity, and in regard to those lying nearest, with the highest velocity yet known. Such examples to a certain extent are most conclusive, and indeed the nature of the subject is such as at once to send home the conviction that, assuming the premisses to be true, revolving motion under all governing bodies, whether suns or planets, must be slow or rapid in exactly the same degree as they themselves rotate, after, of course, making allowance for the distances at which these subject bodies are from their rulers.

The movements of the planets round the sun in all cases being as closely linked to his axial and only motion, although with bonds that are invisible, as the parts of a machine to the central force that guides them, is not the only proof that rotatory motion is the acting power that governs the universe. It is in an equal degree established beyond all doubt, not only by the positions of the planets lying on the plane of the sun's equator, but likewise by the satellites holding similar relations to the

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observed, but there is an unknown law in relation to all lunar bodies by which their orbital and axial revolutions are known to be in the same exact time. The exterior satellite of Saturn takes 79 days in going once round its orbit, which, in harmony with the unknown law we have mentioned, marks out that long period as the time of one of its axial revolutions to a second. It is certainly much the slowest rotatory motion yet known.

primaries in all the secondary systems. Thus, beginning with the earth, we find the moon rolling round it on an orbit diverging not much from that part of its body on which the greatest force of its rotation centres, its equator; Jupiter again holds four bodies in subjection, and they are one and all entirely under the guidance of his rotation, moving harmoniously in the same direction with him, and as he turns round on his axis their revolving rates increase and decrease, according as they are near or remote, like the planets of the sun, which lie or rather revolve on, or nearly on, the plane of his equator extended. But of all secondary systems, that of Saturn affords the most beautiful and varied proof of any governing body—not even excepting the sun himself—that rotation is the mighty lever or motive power that produces the revolutions of all secondary bodies, by the effects of this influence on his rings and satellites. First, there are the rings concentric to each other, and the equator of the planet concentric to the rings,—cause and effect thus harmonise together, each one of the rings spinning round once in the exact time the planet turns on his axis.* The rings are concentric, because the rotatory force of the planet gradually inclined them to that position from the respective angles of inclination they first held at the time of their formation; and the planet's equator being concentric to the rings is just the relation, and no other, that they could hold, for it is along the equatorial line that the rotatory motion centres in its greatest force. Finally, to complete the picture, in the greater distance there are seven other bodies, revolving on orbits in their respective positions; of course, going round in one uniform direction their orbits concentre to one another, the rings in turning concentre to them, and the equator concentres to the whole. In other words, all the bodies, both annular and globular, lie on, or nearly on, the plane that coincides with the planet's equator, just as the planets do under the guiding rotation of the sun, all going in perfect harmony with the wheel-like motion of the planet, and with as much regularity as the parts of a common machine obey the moving power in its centre.

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* We are not actually aware whether or not the spinning motion of the rings round the planet has been ascertained by the usual aid of visible spots, but, nevertheless, they as surely whirl round as the satellites outside of them revolve, and their close proximity is a sufficient proof that they must, hooplike, go round once for every turn the planet takes on his axis. Thus revolving motion accelerates always in exact proportion to the nearness of the governing body; and although we know no instance of any planet or satellite revolving once round for every turn of the axial motion which governs it, this is because they are all, in the various examples that our limited knowledge can produce, too far removed from the motive forces that impart to them their revolving motions. At all events, if bodies do anywhere exist sufficiently near to the planets or suns which rule them, they undoubtedly go round *pari passu* with their motions, and it would be a very simple task to prove, by calculation, that the rings of Saturn, in relation to his rotation guiding their spinning movements, are within such limits.

We have now briefly travelled over the whole field of human discovery, so far as it is available on this subject, and wherever we go, we find rotation and revolving motion hand in hand together as cause and effect; to this rule there is no single exception to the contrary. The sun rotates and all the planets go round him in the same direction; and lying as they do on the same plane with his equator, it must incontestably be in obedience to that motion. The earth rotates, and the moon follows the example, likewise, of going round in the same direction. Again, the moons of Jupiter are guided by the same general law that gives motions to the planets and the moons of secondary systems; finally, the most convincing example of the whole being the rings and satellites of Saturn. These are all the bodies, or rather systems, it is possible to refer to; but in the overwhelming proof they afford, and by everything connected with their government, we, at all risks, unhesitatingly affirm, that if we could at will traverse the regions of space, we should discover that all bodies, governing and governed, hold the same relations to each other, and thus be enabled to exhibit the whole creation in proof that rotatory motion, linked to its handmaid attraction, or some unknown force, is the sole active agent in the government of the universe.

We must, in the next place, meet the question, How does rotation act upon subject bodies in order to produce their revolutions? Before giving a reply, let us explain that government would be impossible, if the bodies governed could give the least resistance to the forces acting upon them, or if they met with the least imaginary opposition in being wafted round in space. In passing round their orbits at the great velocity they do, if they encountered any, even the faintest opposing force, they would at once be stopped, yet it is held by some that they actually do meet with opposition, however slight it may be. The movement of the planet Jupiter should settle the question, for on account of its breadth of surface its motion would be very much retarded and extremely slow if it encountered any opposition, but we find that, according to its distance from the sun, it moves round its orbit at precisely the same rate as the smallest body in the system; and as the rule holds good when applied to all the planets—great and small—as compared with each other, so far, then, as opposition to their orbital movements is concerned, such universal examples should remove all doubt. As to the total absence of resistance in the bodies themselves, it may be better understood by referring to the force of the sun's attraction upon them respectively.

The attraction of the sun undoubtedly pervades the whole system, but how far it actually spreads its force into distance, or if at a certain remoteness it would cease to have effect, or rather wear itself out to nothingness, we will not here determine. We know, however, that it extends and makes itself felt as far as Neptune and considerably beyond, even outside the limits of, the aphelion of Halley's comet, for both these bodies, being subject to the sun's government, prove the presence of his attraction, weak as it may be. It is evident, therefore, that the solar attraction must reach beyond where the motions of these bodies lead them; but at such great distance it can only be very feeble, in fact all but infinitesimal, yet it is a something which proves itself all-powerful in gently leading them round and round in space, grasped, as it were, within the tenderly stretched-out arms of attraction, with the same facility as if the force applied was ten thousand times stronger. In these bodies then, it is undeniable that there can be no resistance, for so great a body as Neptune, where the attraction of the sun is so weak, could not be moved if capable of resisting in the least degree. Indeed, if the bodies nearer the sun gave the least resistance, where his attraction is vastly stronger, they could not be moved, and their government would be impossible; neither could any body in the heavens be put in motion, if it had a resisting force in the lowest degree, or if it met the least opposition. The cause of their non-resistance is that, in regard to weight they are, if you will, great hard compressed entities, or hanging shadows in space, and so incapable of resisting—that if it could be applied externally, uninfluenced by the attraction of the body acted upon, the impulse of a human finger, or a breath of wind, would set any one in motion, but this only to the extent the applied force would reach.

This view of the total absence of weight, and consequently resistance, in the worlds, taken as wholes, will, we are aware, however capable of demonstration, be sceptically received, perhaps with derision, because from our earliest infancy and universal experience, our association of ideas have ever been entirely opposed to it. On the earth we live, for example, everything feels heavy—the small object in the hand is more or less heavy, the person holding it is heavier, the house we live in is still more weighty, the gentle hill upon which it stands is of enormous weight, and the weight of mountains, islands, and oceans is stupendous. Thus our ideas rise step by step to the contemplation of the mighty weight of this big world in its entirety. Precisely the same notions of the heaviness of the earth and everything upon it are held at the antipodes, and as every spot of the globe has its antipodes, the enormous weights in all directions and from all points round the sphere are opposed to each other, meeting by their pressure at the common centre, the heart of the earth itself, without adding to the great bulk, as a compact whole, the least imaginary ponderosity. The government of the worlds depends upon the bodies as they are constituted, being totally without weight or resistance. Hence it cannot be too often repeated that the heaviness of matter on the surface of the globe has no relation to the weight of the latter *en masse*, for the weight we feel is not from without but from within—from the earth itself, which by its attraction makes things heavy upon it, but cannot impose heaviness upon itself. Any matter, whether it be a clod or a world, to have weight must derive this property not from itself, but from another body acting upon it with sufficient force to deprive it of its own centre of gravity. If that could happen to the earth by the attraction of the sun imparting to its whole enormous bulk of matter only the weight of a single grain,* its fate would be sealed. At first, because of its next-to-nothingness of weight, it would begin its gravitation to the sun with imperceptible slowness—a motion which would be accelerated the nearer it approached, as its weight would increase till very soon it would bury itself in the bosom of its great destroyer, and that at a moment when it had attained a weight past all conception, seeing that its materials would be as much heavier as the attraction of the sun at his own surface is stronger. This would be the undoubted and inevitable fate of the earth if placed within a million miles of the sun ; but in the position it holds, it is as safe as that great body itself, and so are all the bodies in the system above the size of aerolites, simply because they are large enough to be attractive centres, and this, and not their motions, is their true support. The sun on the same principle is supported, for he has no revolving motion, and if his rotation was to stop, all the primaries under him would at that instant stand still also—just the same as the parts of a machine if the turning motion ceases to act upon them—and like their great ruler be as little suns themselves, immobile in their places ; and for the oft repeated reason that in themselves there is not a grain of weight, so that they require no support.

Before directly entering upon how rotation is made to act so as to impart revolving motion, we may summarise our previous remarks by observing that there are three primary principles, each indispensable to the other in the government of bodies—namely, attraction, rotation, and a total of absence of weight in the bodies governed. On these three principles our future conclusions, together with those that have preceded, will mainly rest, whatever they may be worth. Attraction, or a something unknown, is the force itself, but if it stands still it is only a sleeping force, under which all the parts of the machine are dead and useless. If it is set to work by rotation, the motive power—both acting in unison—keeps the machine in all its parts in operation. The work goes on by a force set in action by the central wheel, but no particular measure of force is required, for there is no resistance, and only in this last material point do the Divine and human machines differ: rotation sets them both to work, acting on visible and invisible springs; but the machine constructed by human hands meets with resisting force in all its parts. We must, therefore, consider them respectively as engineering works coming from an imperfect and a perfect source. Man himself is an imperfect being, and his greatest works cannot be perfection: the Almighty Engineer constructs an engine that is worked precisely on the same principles on a larger scale, but all is perfection; there is no friction or resistance in its parts—it keeps worlds on worlds in motion with the lowest measure of force we can imagine, for they meet with no opposition, and they themselves are weightless, hard, solid nothings, so to speak, that float as shadows offering no resistance. On these principles, the government and safety of the universe is only possible.

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* If the earth had no attraction in itself, or rather, if its attraction as an opposing force was suspended, then taken as a whole, if put in the balance, it would be of a weight equal to the sun's attraction upon it ; but having within itself this property in common with all other bodies, weight cannot be imposed upon it till the attraction of the sun is stronger on its surface than that of its own. Thus acted upon, it could then, in the first instance, as a body, only be of a weight equal to the difference in the balance of the opposing forces, perhaps only a grain at first, but that identical fatal grain of weight would quickly increase beyond measure and soon lead it to its doom.

Rotation is the motion that governs the universe by its action on invisible force; and as it is a motion we suppose to be common to all celestial bodies, each one is endowed with a power of governing, according to its magnitude and its relation to others; but it would be very erroneous to conclude that such grand effects could be produced by the motion itself, without the unseen force put in action by it. The turning of the sun simply on his axis, or that of any other body, would be as powerless in itself of imparting motion to the bodies under him, as the big water-wheel if disconnected from its machinery; and were it not that his turning or rotatory motion acts upon hidden springs that bind all together, they would remain at a stand, fixed and immobile. The sun is a great wheel, tied to all the parts of his machine by currents of invisible force, and if he did not turn, they would stand dead and still; but he does turn, and the springs that connect them all in common turn along with him, and lead all the parts or bodies round him—at their various distances—from west to east. The effects produced, therefore, demonstrate to a certainty the invisible force, and except it be attraction there will be considerable difficulty in defining it, although, by reference to experiments familiar to most people, we may perhaps, to a certain extent, be enabled to explain it.

At sea, the experiment is often made of dropping an object, say a bronze coin, from the mast-head of the ship when in full sail, yet the coin invariably falls to the bottom of the mast, notwithstanding that during its descent the ship may have moved twice the length of herself. The important question here arises, Why does the object thus fall in a straight line with the mast, instead of descending perpendicularly and so in the rear of the vessel, in obedience to the attraction of the earth? The movement of the coin in its descent coinciding with that of the ship, proves that there is some other force besides attraction acting upon it while in mid-air. If the same object, or a stone, for instance, is thrown from the deck, similar but much more striking effects are produced. Thus if the object, whatever it may be, is thrown so that in no part of its course it will be perpendicularly clear of the ship, it will fall back to the deck, and that on the exact spot as if the same operation was performed were the vessel lying still in the dock, although while in the air the ship has moved a considerable distance. If it were possible for the ship to go at lightning speed, the result would still be the same. It is impossible that the vessel could escape or run from under the falling object the thousandth part of a hair'sbreadth; and even supposing the object could be disenchanted of all attraction, it would then of course be without gravitation, and from the unknown influence of the ship's motion upon it, at the particular elevation from the deck it might be in, it would unquestionably continue to accompany her in her sailing motion, and never be left behind, precisely on the same principles as the moon follows the twofold motion of the earth, on its axis and round the sun.

The foregoing experiments have frequently been made by the author both on shipboard and from moving vehicles on land, with the same results in every situation and under all possible circumstances. Thus, an object thrown up from an open carriage running at full speed, if thrown to a moderate height so as not to be out of the perpendicular of the carriage or other vehicle, invariably falls back upon it, the same as if the vehicle were standing still, instead of dropping in the rear, which it undoubtedly would do if there was no other hidden force besides attraction acting upon it. Again, if a pebble is thrown into the air from an open railway carriage, running say thirty miles an hour, although the train would move perhaps the full length of itself in the meantime, in all cases the stone would drop upon the particular carriage it would otherwise have done had the train been standing still. That this result, however, may be produced, it should be noted that the object must be so thrown that throughout its ascent it will be perpendicular to some part of the carriage or carriages, or in its descent two motive forces at the same time act upon it, and deflect it in its fall, more or less according to how far it might be thrown sideways. If thrown so as to drop close outside the carriages, the train during its fall would gain little upon it; if thrown at a greater angle out, it would in the same degree be left behind by the train; and, lastly, if thrown at right angles, it would light on that part of the ground it would otherwise do if the train was at a standstill, its motion having no effect upon it. Such experiments, therefore, incontestably establish the fact that an object thrown up from a moving body, in a sufficient degree larger than itself, is subjected to two forces with equal control over it—namely, the motion of the body from whence it ascends; and the attraction of the earth, that under any circumstances will bring it down in the same time, although, when thrown up, during its fall it has to traverse a distance of three, or perhaps ten or a hundred times the space it would have to pass if projected from a body not in motion. As will be observed, the distance passed over during its fall depends upon the rapidity of the body from whence it is thrown. Astronomically we contend that these facts prove, as we have said, without a doubt, that the motion of a greater body, under every possible condition, imparts motion in the same direction to a smaller body hanging above it. Let the attraction of the earth only cease to act on an object floating above a moving body on its surface, so that it would be without gravitation, and it is self-evident that, no matter how rapid the motion of the body under it might be, there it would permanently hold its relative position, or rather the controlling motion would lead it to the end of the world. A natural severance of the two would be as impossible as that of the moon from the earth. The same principles not only apply to the motions of ships and carriages, but in like manner to the millions of objects thrown up and floating over our earth, and it also extends to all the planets and satellites of our system, in connection with their ruling bodies, and no doubt is common to the universe.

To prove the universality of the principles we are maintaining, and to show from the examples how revolving motion is guided by rotation, let us shift our ground to another class of objects with which we are all familiar, and from them reason up to the heavenly bodies themselves. A stone, for instance, thrown perpendicularly up from the earth, if such a feat was possible, would unerringly return to the same spot, and if pitched in any other direction would only return to the ground at a distance equal to the projecting force; but during the time that it is up, the earth turns on its axis, perhaps a furlong—that motion on the equatorial line of the earth's surface being about a thousand miles an hour. Here is the phenomenon of the stone thrown up from the ship repeated in every particular. The stone, instead of falling behind the distance the surface of the earth turns round, or rather rotates, the time that it is up, returns from whence it is thrown, thus accompanying the terrene motion, just the same as when, thrown up from the deck, it goes on with the moving ship. A bird hovering on the wing for perhaps hours at a time affords another beautiful illustration. During the time that it is flying, without the least effort of its own it is carried, or rather revolves, round perhaps a thousand miles, simply by the motion of the earth imparting to it a motion in the same direction; or in other words, a greater body imparting motion in the same direction to a smaller one *pari passu* with itself. It would be a waste of time to multiply instances, for the principle is universal. The same results are demonstrated by every object thrown, every bird or insect on the wing, every drop of rain or flake of snow that falls from the clouds—by the clouds themselves, by the atmosphere, and every atom that floats around us. These all accompany the motion of the earth—on the same principle that a stone thrown follows the motion of a ship or carriage—up to the highest atmosphere and far beyond, to the moon herself. She is carried round and round the earth by the same motion that acts on the smaller objects below, by some grand occult principle that keeps all in harmony together, and without which the moon would be forsaken, the atmosphere with all it contains left behind, and the ocean itself, by the same force, if not parted from the earth, would at least rush backwards from its lowest depths and deluge the land.

All the above examples from the moon downwards are in reality revolving motion, as applied to every atom or object respectively. The projected stone being obedient to the earth's rotation while it is up in the air, is, in reality, revolving motion on the lowest scale, and if it could be deprived of gravitation, and thus remain up, it would continue, like a planet or satellite, revolving round the earth so long as heaviness would not be re-imposed upon it. We need hardly add, that the same holds good in regard to every atom or particle of matter floating over the earth's surface. Turn which way you will, millions of objects are to be seen revolving, whether influenced by the motion of the earth or by artificial motion; the effects, although in the latter cases necessarily limited, being much the same. The stone travelling with the carriage or the ship, is, scientifically speaking, revolving motion artificially produced; the objects and atoms floating above the earth in myriads, ending with the moon herself travelling round with the rotation of the earth, is revolving motion. In like manner it is the same motion in the planets of the sun, and the satellites subject to secondary rule. They all move round in harmony with the rotatory motions which guide them, in the same way as the innumerable objects referred to, thus giving us a universe of evidence that all greater bodies in motion draw other and smaller ones, if near enough, round them; or, in other words, motion imparts motion in its own direction from larger to smaller bodies. This principle being thus capable of universal demonstration, the causes of revolving motion can be as incontrovertibly established as the truth of attraction itself.

Rotation, as before observed, taken simply in itself, can have no effect in imparting revolving motion to bodies; it therefore must act upon some mysterious force that produces these grand results, and whatever that force may be, it permeates the universe. The question remains, What is the hidden force acted upon by rotation, that displays through all creation such grand effects? Is it attraction, or is it not? If it is, the question is answered; if it is not, human knowledge cannot give a reply. It would be an easy matter to pass over the question, and take for granted that attraction is the force itself that rotation acts upon in producing revolving motion, as such a conclusion would offend no prejudices; but in studying the nature of attraction, and the manner it is known to act in straight lines—centring into its source perpendicularly—it seems repugnant to reason, that thus acting in direct lines it could lead bodies round on circular courses. However, they do move on lines more or less circular, and with such universal proof before us, there is not a shadow of doubt but that rotation is the motive agent that sets the hidden force in action, and so produces the results. The bodies themselves being totally without weight, and consequently resistance, anything, even the least force the imagination could conceive, would doubtless be strong enough to lead them round their orbits, and the attraction of the sun as it were grasping them, coming as it does from a rotating body, the straight lines of attraction turn round with it as well, and thus the bodies within its embraces being on the move, may be led round, and therefore from this agency derive their orbital motions. This is the only explanation we can conceive of how attractive force is made by rotation to act so as to impart revolving motion to subject bodies, and although it is one naturally lame and unsatisfactory, yet it would be presumption in us, while we are incapable of finding a substitute, to even hint that any other undiscovered force produced revolving motion, were it not that we have in the examples of revolving motion artificially produced the clearest proofs—and they only can be tested—that attraction can have neither act or part in imparting to them such motions. The examples we refer to are the objects thrown up from bodies in artificial motion, and beginning with these experiments, from which all our ideas on revolving motion, whatever they are worth, have sprung, we have reasoned from object to object up to the heavenly bodies themselves, so as, to the best of our humble ability, to make clear and intelligible the universal law which guides revolving motion. The stone thrown up from the ship, technically speaking, is not revolving motion, for it does not go round the body whose motion leads it along, yet it is acted upon by the motion of the ship in the self-same manner as a planet is by the rotation of the sun. In both cases it is the motion of a larger body giving motion in the same direction to a smaller. The motion of the one, the sun, is circular, and in harmony with it the motion of the planet must be more or less circular, while the motion [of the ship is horizontal, and the governed motion of its subject body, the stone, must also be horizontal ; but notwithstanding these diversities, precisely the same law that guides the planet conducts the thrown-up stone with the motion of the ship. This motion of the stone with the ship's motion being—scientifically considered—controlled in the same way as the revolving motion of a planet by the sun, if the stone was only deprived of gravitation it could never be by natural causes parted from the ship, its governing body—whether standing still or sailing—it would be as inseparable from it as a satellite from a planet. Now the force of attraction has no part in making the projected stone travel with the ship. If it had, instead of accompanying the motion of the latter, it would leave it behind and follow the motion of the earth, from whence proceeds nearly all the attraction acting upon it. The stone falls with the same rapidity as if the ship was at rest, showing that the attraction of the earth under all circumstances wherein it can act is supreme.

The attraction of the earth, however, has no influence on the forward motion of the stone with the ship, the motion of the latter predominating over the terrene motion in carrying it along; and thus the fact is incontestably established, that borrowed motion, in such instances as this, is in no way indebted to attraction, for if it was, the stone would undoubtedly obey the stronger force, leave the ship, and be, while up, led only by the rotation of the earth acting by its attraction. The same holds good in all cases of revolving motion imparted to objects artificially, whether they may be thrown up from a ship, a railway train, or any other moving vehicle, and while they afford beautiful illustrations of the causes of planetary motion, they are in themselves so many proofs that attraction can have no part in producing them. In all instances, the objects when thrown up travel *pari passu* along with them, the predominating power of the earth's attraction, although pulling them down, having not the least influence over the objects in respect to the revolving motions artificially produced by the bodies from whence they are thrown. The worlds, on the same principles, being guided in their orbital motions, there is, therefore, some evidence in the examples of the objects referred to—but by no means conclusive—that their motions round the heavens may not be indebted to attraction, as the applied force. If not attraction, we repeat once more, what is the unknown force that rotation acts upon in imparting revolving motion from larger to smaller bodies? Is it by some hidden undiscovered law, or are we tempted to ask has light some mysterious influence in it* for the purpose? or are there currents of electricity pervading all space, that, set in action by rotation, produce these great results? Some Newton may yet arrive who will solve these difficulties, and reveal to mankind one other of the unknown sublime forces that the Great Omnipotent has bestowed for the government of His creation.

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* Since writing the above, the wonderful discovery by Crookes on the power of light in imparting motion has been published. As a force linked to rotation, it might be the means of clearing up the difficulties of celestial motion, in which case light would be the force put into action by rotation.

CHAPTER III.

AXIAL MOTION.

THE principle of rotatory motion itself, the acting agency in the government of all bodies, must for the present be dealt with briefly and very imperfectly, for the true causes from whence it first originated cannot be made intelligible except in the concluding chapters, only in so far that we suppose some of the planets may have received this motion at the first, by having their equilibria disturbed by such external impulses as they are still subjected to.[*] We must therefore treat the question in this light at present, and that a vague idea may be formed upon it, let us observe that at the beginning it is quite possible natural operations were at work which imparted impulses to all secondary bodies that may have endowed some of them with their present axial motions. The forces that produced these results, however powerful they were in themselves, required but little strength for the purpose, as, whatever their nature, they acted upon small bodies in the truest sense passive and irresisting. Each of these bodies was a gravitating centre, floating in safety upon nothing, and with not a grain of weight in itself. They were the same as all bodies are now and always have been, so non-resisting that the gentlest impulse, even the touch of a human finger, would set them spinning, and not running off on interminable straight lines, as many thinkers conclude ; but whatever the force of the colliding impulse, the body as to weight being no heavier than spirit, or shadow, it could not have motive force. Thus it was only possible for it to be moved on so far as the impulse reached; but if the latter was powerless to send it adrift, the colliding blow once given, however slight, had the effect of turning its equilibrium, and setting it spinning on an axis, and that in the direction the impulse acted, quick or slow, according to the nature of the impact, or the action of internal force. But although the least touch or impulse is powerful enough to set a world turning on an axis, the force must come quite independently of the body struck, or rather to some extent it must be given by the colliding or smaller body, and that independently of the attraction of the larger body upon it. When there is such a difference of magnitude betwixt the two bodies that the attraction of the larger brings on the collision of the smaller wholly by the action of that force, there is in such a collision no impulse given by the smaller body to the larger, and consequently no disturbance of its equilibrium. Our earth, for example, when first set turning on an axis—its primal turning proceeded from natural causes and not from external impulse—was but a mere handful of matter, a planetoid of the lowest type. It would, therefore, be a very unhappy example to take in its present enlarged condition, and especially to illustrate by it how the rotatory motions of some bodies might have been borrowed. As a body, it is constantly receiving innumerable impulses both from without and within, any one of which at the beginning might have given it rotation when so slight an impulse was required. In its present state, they could have no effect in disturbing its equilibrium, or of imparting to it a quicker or slower rate on a new axis, as it might be for the very conclusive reason that all the impulses that it is the recipient of and the convulsions which it is subjected to, either proceed from, or are brought on itself, by its own attraction or internal action. Its shell, for instance, or what is termed its crust, sometimes cracks, through the escape of pent-up gases, by which the surrounding surface is, on rare occasions, disturbed with such violence as to be depressed beneath the ocean; but the forces that produce these changes—the most violent the planet is subject to—are generated within itself, and therefore, in the sense of giving it a new axial turning, could have no effect upon it, for all are equally opposed and neutralise each other. The impulse to disturb our globe, or indeed any other body, and set it on a new axis, must come from without, and strike it with an independent force, and not from the power borrowed from the earth. Aerolites, for example—they strike the earth by millions—may at first sight be looked upon as impulses from without, but the forces they are endowed with are all drawn from the earth, and consequently their contacts are harmless. Thus an aerolite, after falling by gravitation millions of miles towards the sun, if it trips on the earth's sphere of attraction, is instantly deflected to a new centre by stronger attraction. It approaches or rather falls to the earth without any inherent force in itself, nor is it impelled in that direction by any exterior force. There is therefore no impulse given by its fall, but only an addition of matter incorporated with it which, from the moment it began to be attracted, was as much a part of the earth as a clod on its surface. We must therefore look to the revolving motions of the colliding bodies themselves, and not to attraction, as the direct force for the primal impulses which produced axial motion, and especially so in such cases where this motion was renewed by exterior forces.

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[*] Secondary bodies, we suppose, derived their rotations from two causes—namely, when first raised to be attractive centres the change itself was all-sufficient to bestow the motion upon them, and the impulses they were then exposed to—suns in their formation, which preceded that of planets, were exempt from such impulses—by smaller bodies of matter falling into them. Each impulse, if any of the force proceeded from the colliding bodies, imparted to them a new rate of rotation, and in a different direction to the previous one, according to the manner they were acted upon. Rotation thus imparted by external impulse is the branch of the subject which can only be entered upon at present. We cannot touch in this chapter the much more natural action within the body itself at the instant its attraction first pointed inwards. This last view harmonises with the order of nature, and may in itself account for axial motion being perhaps common to all celestial bodies ; but the planets have all been liable to collision in the initiatory steps of their formation, and when little bigger than the colliding bodies, it is possible that the existing rotations of some of them are owing to these causes.

To enter into this larger question involved is impossible at present. Justice could not be done to the subject in this chapter, and we can therefore here only intimate that at the beginning, when planetary formation originated, a vast number, perhaps millions, of small collections of matter as planetoids were all revolving on orbits as independent bodies; for want of room to move free of each other, they had to intersect at myriads of points, and, as time rolled on, no one of them—being all liable to stumble upon each other at the crossing points—was free from collision, no doubt many times repeated; in nearly all such cases mutual incorporation taking place. When any collision happened, the smaller of the two planetoids, to have any effect in giving rotation to the larger, had, in imparting the impulse, at least to be partially free from the influence of gravitation—that is, it brought a force derived from its previous revolving motion, independent of the action of the larger upon it. The larger thus received the shock by another agency than the force of its own attraction, and had its equilibrium disturbed by an outer force; and if there was a repetition of such impulses, which then in some cases were frequent, it was made to turn on a new axis, and that with a motion quicker or slower than its previous rotation, and in a new direction, according to the action of the impact. Every aerolite or planetoid that falls upon our globe is the result of one of these collisions, that frequently repeated may have at first produced in some bodies planetary rotation; but the earth as one body has become too large, while from age to age, beginning with the first formation of worlds, as a class of new created objects of matter they remain according to their proximity with great centres much the same. The earth, therefore, if it really owes its axial motion to external impulse, instead of more natural causes, received its last knock when little and young, the colliding body bringing some force with it, less or more—plus the attraction from our little asteroid drawing it in. From that remote period to the present, it has been the constant recipient of millions upon millions of impulses from aerolites, and perhaps once or twice in a century from planetoids, but in its enlarged condition they can have no effect upon it, as the force of their descent entirely proceeds from its own attraction.

At whatever stage of growth a body in its early existence may be, when once endowed with rotatory motion, it will go on moving at the same rate and in one direction without change—for rotation is a motion that cannot stop of itself—up to the time, if it should ever come, when by collision it receives, under all the requisite conditions, another impulse from a falling body, in which case it is again put upon a new axis, has a different rotatory rate, and other changes in conformity to the direction and nature of the impact. Time, however, has so far enlarged the globe, that we may suppose this to be the last colliding force, at whatever time it happened, powerful enough to affect it, and the same applies to all the planets that owe, if any, their axial motions to such impulses. They are, to a certain extent, still acted upon by the same colliding forces as in the past, when they were susceptible of the changes described; but now, because of their enlarged magnitudes, the collisions act harmlessly—not only now, but for long in the past—and there is little doubt their rotatory motions will continue the same without change as far into the remote future as they will be permitted to exist. If so, and we think it will be questioned by no one, this establishes rotation as the only motion that cannot stop, and must from its nature go on for ever, perfectly free from all control or any force that can be made to act upon it. As a motion, it holds absolute sway over all secondary bodies, but it cannot itself be acted upon, and it is this—its entire independence of all material force—that constitutes it the ruler of the universe. The sun is truly styled the monarch of the system, but deprive him of rotation his subject bodies would stand still, and his influence over them be at an end, except that they would be within the grip of a stronger sleeping force, which would prevent any other body or bodies usurping power over them.

The fact that rotation is an acting power, in itself absolute, that all other material forces are in subjection to it, and that it is the motion which governs the universe, we think is clearly demonstrated by what has been already advanced, yet, at the risk of repetition, it remains to be shown that no other forces have any influence or control over it, so that, when once in operation on a body, it must from its nature go on without change for ever. Admit these premisses, and rotation ranks far above its kindred revolving motion. The one governs absolutely, without any control over it, while the other—revolving motion—is governed; and in all its movements the latter is as much controlled by the former, as the machinery is subject to the rotation of the central wheel which acts upon all its parts in common. The planets of the sun, and the satellites of the planets, by their varied motions, all prove these facts. Taking the former, if the sun had the least power over their rotatory motions, like revolving motion, they, in turning on their axis, would be subject to some fixed rules, such as spinning round in a uniform direction, and at rates of motion decreasing according to distance; but it need scarcely be observed that these motions, by their actions, prove that they are free and independent of any guiding force from the sun, and consequently from all other forces besides. No two of them rotate at the same rate, and comparing these motions in the sun, moon, Jupiter, and Saturn, respectively, we have the examples of the axial turning of the two latter rotating with sixty times the rapidity of the former, while all the other bodies, whose rotations we have discovered, turn at intermediate rates, varying more or less from each other, but quite irrespective of their distance from the sun or any other material forces whatever. Again, the arbitrary directions in which they perform these motions leaves the question beyond a doubt, that no forces in existence can in this respect have the least influence over them. Instead of turning in one direction, as is the case with their orbital motions—considering the very few in which axial motion is discovered—they turn in all directions, according as the primal impulses may have acted upon them. Thus Uranus rotates from east to west, and some others move more or less in the direction of from west to east, south to north, and north to south, and intermediately. We think that, without enlarging upon the subject, these and the other reasons given are sufficient to set the question at rest, that rotation, while it with absolute power imparts revolving motion to bodies, is in itself free from all control, and is by nature constituted to go on without end, at the same rate, and in the same direction, in every separate body, as was at first imparted to them at the beginning.

It is quite common to teach children the nature of rotation by a ball being made to turn on a wire, but it has this drawback, that without repeated impulses it soon ceases to rotate, while celestial bodies require no fresh impulses to keep them turning, and so long as they are free from such, their axial motions can never cease, neither can they increase or diminish. The ball is soon at rest from its turning motion through the attraction of the earth giving it friction on the wire, and without it the same force would pull it down, but could have no effect on its rotation during its fall, whatever distance it might have to descend. Again, if attraction at all points ceased acting upon the ball, it would no longer gravitate, and if set spinning on the wire, which latter we must now look upon, like the axis of a planet, as imaginary, it would unquestionably continue turning at the same rate, and in the same direction, for any period of time—that is, so long as it held such relations with other bodies unchanged; and under these circumstances, if collided upon by other revolving objects, the collisions would have no effect in stopping its turning motion. In a body, large or small, once set a-going on an axis that would be impossible; but its balance by each impulse would turn in a new direction, giving it another rotation on a different axis, on which it would go on without change, as before, till a repeated impulse of revolving matter might impose a fresh axial turning upon it.

The largest worlds were at one time no bigger than the ball, and when in that embryo state subject to such vicissitudes, they grew apace till at last they became large enough to become the receptacles of smaller collections of matter—aerolites and planetoids—by simple gravitation, so from that to the present we suppose the changes of axial motion in most of them have entirely ceased. True, many planetoids, approaching in size the asteroidal class, must have existed in the chaotic stages of creation, and by intersecting the orbits of the larger bodies came into collision in course of time with them, or in extremely rare instances became appended as moons. These operations, at least in connection with the earth and the other minor planets, have long ceased, and we may reasonably conclude that no such causes will ever again impose new rotatory motions upon them. This applies in an equal degree to the four major planets, so far as is yet known, and to satellites; but we suppose it is quite different with the lowest visible of the asteroidal class downwards. Of these, considerably more than a hundred have already been discovered over the space intervening betwixt Mars and Jupiter, and, on account of their position being in a separate division of the system by themselves, the region they occupy might properly be termed the asteroidal zone. Over the solar latitude in question, they no doubt, known and unknown, exist innumerable—from the smallest planetoids up to the size of Juno, which has so far increased in magnitude as to take rank with lunar bodies. These bodies, discovered and undiscovered, visible and invisible, cross and intersect each other's orbits at myriads of points; and if it were possible to be wafted into their midst, collisions between these imperfect creations might sometimes be witnessed, such as may have imparted the last axial motions to the larger planets at a much earlier period.

From every view we can take of the natural operations which at the beginning originated rotation, it seems all but impossible that any body can be without this motion. As it is, therefore, the acting power that governs all subject bodies, it follows that there is no independent body, if it has rotation, but is naturally endowed with power to rule over a system of its own, if only other smaller bodies were within the sphere of its attraction. The reason is obvious; bodies lying within their respective spheres of rule can be subject to no other attraction acting more strongly upon them. Take one example, the moon. She is certainly alone by herself, but if a much smaller body existed within the narrow precincts in which her attraction is strongest, it would revolve round her in tertiary subjection, in like manner as in a lunar state she goes round the earth. The reason likewise applies to all independent bodies, no matter how low a grade they may be. They are all surrounded with their attractive spheres more or less expanded, within which their own native forces of attraction are severally stronger than the attraction of any other bodies within the same limits. Any subordinate bodies within such limits are as much under their control as the planets are to the sun. The sun, no doubt, causes them to roll round him in company as small systems; but the included satellites are as independent of him in their motions round their primaries as if he and his general controlling power had no existence. In short, if the sun were annihilated and no other force left to supersede him, these same planets would, as suns, stand still, and their moons thus promoted to planets would undisturbedly perform their revolutions just the same, notwithstanding the change.

All space, we will take for granted, is pervaded with attraction, at least such divisions as are dotted with the material universe, or if otherwise it would not affect our inductions. Every portion of space that attraction reaches has the attraction of some one body stronger over it than that reaching it from without. The largest body within each portion of space rules supreme, and the attraction of no exterior body exerts the smallest influence within that area, simply because its attraction is the strongest that acts on the bodies within it. The limits over which a sun or planet thus rules is what we term its sphere of attraction, and as it has been more especially through the agency of secondary attractive spheres that planetary formation has in great part taken place, to have comprehensive views of the attractive spheres of the sun and his planets, we may be permitted, on account of the importance of the subject, to employ some savant to survey the whole in person. It would be beyond the power of a mortal to perform the task, therefore the only being capable of marking down this celestial map must be an angel. Such a messenger would have this advantage, that he could pass from point to point through the heavens with a swiftness exceeding the motion of light.

His philosophic apparatus would be a pebble, and with it he would mount sunward till he reached outside the lunar orbit, where he would first use his instrument, the pebble, and dropping it would discover that he was still within the space governed by the earth's attraction in that direction. In an instant he would be several thousand miles farther away, when the experiment would be once more made, and it would be repeated again and again till at last he reached a certain line on which the pebble would remain stationary—the attraction of the earth and sun acting equally upon it, thus holding it at a standstill. Beyond this line the celestial savant would discover that the pebble moved sunward, and inside of it earthward. He would therefore justly put down the line where it remained stationary, at whatever distance that might be, as the extreme limit of the attractive sphere of the earth in that direction. In another instant he would be on that side of the earth farthest from the sun, and would at once find the dividing line in this direction to be at a greater distance from the earth, he being on that side more remote from the sun, wherein his attraction is somewhat weaker; but experimenting a few thousand miles farther out the true dividing line would in like manner be discovered. Thus with seraphic celerity he would ascertain at all points round the sphere the extent of the earth's predominating attraction, marking out the space with mathematical nicety, finally presenting it, whatever may be its expanse, of a spherical, or rather a spheroidal form, surrounded at all points by the dominion of the sun. It would likewise be discovered that the earth, instead of being in the centre, always holds a position nearest that side of its attractive sphere opposed to the sun, and that as it revolves its expanse of predominancy contracts or enlarges several thousand miles, according to its proximity to the ruling body on the different parts of its annual course; throughout its rounds the moon being always inseparable in obedience to the laws of motion, by which she as a smaller body is led by the motion of a larger and in a lunar condition is governed. So far we have explained the nature of the outlines of our attractive sphere, but its true expanse we cannot of course determine. It must, however, in every direction extend out beyond the orbit of the moon, for if the sun's attraction on any part of that orbit was stronger than that of the earth, she would then and there escape from the government of the latter and become a primary planet. How much farther out the attraction of the earth prevails we have very little to enlighten us upon, but the minimum distance cannot well be put at less than three hundred thousand miles. It may be considerably more, but all things considered, and viewing the question broadly, we may safely conclude that the total diameter of our terrestrial sphere of attraction is less than that of the body of the sun.

With the same angelic help and the pebble, the attractive expanses ruled over by Venus and Mercury would be found to be of spherical outlines in every respect like that of the earth, but differing in this particular that they being in nearer proximity to the ruling body, their attractive spheres are narrowed accordingly. Next, there is Mars—the first planet exterior to the earth, but considerably smaller—and it could be easily shown that on account of its greater distance, its attraction rules over an expanse perhaps nearly as wide, and like the others surrounded at all points by the predominancy of the sun. Passing over the belt sprinkled by the asteroids, the next planet is Jupiter, the largest in the system, which from its distance and magnitude must have a very wide expanse of predominant attraction. How wide we know not, but the interval that is known to exist betwixt this body and the asteroids revolving nearest it,* making every allowance for the eccentricity of their orbits, affords us a clue—the reasons for which we cannot here enter upon—by which we derive a vague degree of certainty that the expanse of space cannot be greatly under and might be more than fifty million miles in diameter, and wholly at all points, like the others, enclosed by the government of the sun. On account of distance the attraction of Saturn may be supreme over an expanse double the diameter, and for the same reason Uranus, although much smaller, governs over precincts perhaps not so expanded, but not much narrower than the attractive sphere of Saturn. Neptune, the last of the overgrown planets, ranks third in magnitude, but from its great distance from the sun it is unquestionable that its sphere of attraction must be much wider than any of the others—how wide it would be foolish guesswork to determine, although taking into account its remote position, wherein the attraction of the sun as the opposing force must be in the same degree feeble, it would be no great stretch of judgment to put it down at half a thousand million miles in diameter; it may be less, but very likely it is more. These figures, however, are but a mere venture resting upon no reliable data; but the science of calculation might do something in the solution of such difficulties, for, if it could be achieved, there are few points in astronomy of greater importance than at least having a vague idea of the true measurements of the attractive spheres of the various planets. The ideas we are advancing are only a groping in the dark; but however wide of the truth our observations may be, they serve the purpose of giving a large and comprehensive view of the system as a whole. Thus viewed, the system to the mind's eye is a vast ocean of length, breadth, and depth, with a number of bodies, as primaries, all singly by themselves in its various latitudes—infinitesimally diminutive by comparison—rolling round their parent luminary in the centre and their various attractive spheres; if such divisions could be visible, all would appear in their places narrow or expanded according to their distances and magnitude, but so little compared to the total extent that if the whole of these spheroidal spots were in the aggregate deducted from the dominions of the sun, the largeness of the expanse would not be sensibly diminished. The sun's attraction rules supreme over all the rest, and the pebble, if let go, would descend to him, except inside the comparatively narrow spheres within which the planets are in a secondary degree absolute.

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* None of the asteroids could exist separately without being incorporated with Jupiter if their courses either touched upon his orbit or the space swept round by his attractive sphere.

The predominancy of the sun does not, like his subject bodies, end in a spheroidal form, but in irregular outlines, caused by the dividing lines of the border systems. The attraction of larger suns than our own would meet his borders in convex, the smaller in concave lines, while in the case of those, if any, of nearly equal magnitude the dividing lines would be in the same degree straight. These irregularities on the borders of our system it is of course out of our power to define, as we know nothing of the systems that adjoin,* and the rude figure we have drawn is on the supposed condition that the nearest suns are of average magnitude with our own; but should they be much smaller, which we believe to be the case, it will still meet the purpose we have in view of illustrating our idea as to how suns are related to each other throughout the material spots of the universe.

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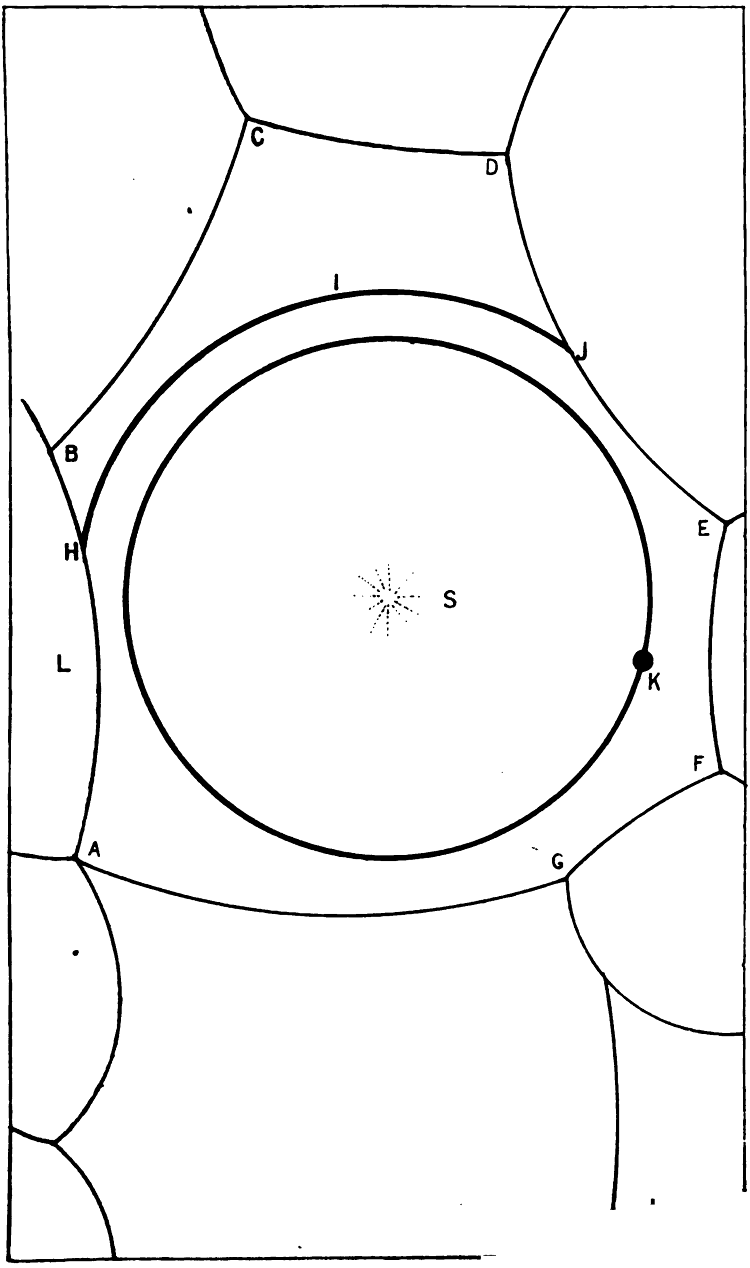
* We are reasoning on a principle at present taken for granted—that other solar systems reach to our borders. This subject, however, will be fully treated in another chapter.

The region enclosed within A, B, C, D, E, F, G, represents, strictly speaking, not the system of the sun, but the entire space over which his attraction is predominant. It may be termed the dominion of the sun. Within this area, by reason of his attraction being strongest, no other sun can govern or exert the least influence. Beyond it our sun has no more power by his attraction than if he was non-existent, for the simple reason that in all situations the stronger force or forces prevail, and the experiment of the pebble would mark out the outlines of the predominating forces of the suns with the same nicety as those of the planets.

It will be seen from the figure, which must be in the same degree irregular—no matter how the sun is actually related to the nearest systems—that his system, whatever the true figure of his precincts may be, must still, allowing for eccentricity, be circular, and can never extend wider than the dominion of the particular sun that projects nearest. Thus, S, the sun, is in the centre of the system, and no matter how many planets may be subject to his sway, known and unknown, the planet, K, on its orbit must be the most remote, or rather it describes the outer ring of the system, because a more expanded orbit would at one or more points touch outside the sun's limits, and thus subject the planet describing it to a new allegiance. If, for instance, a planet wandered out of the precincts of the sun, L, at the point H,—a thing impossible—it would at once become subject to the rotation of our sun, and on its new orbit it could only describe the part circle H I J, at the termination of which it would plunge into stronger attraction, and so commence an orbit *de novo* under the sway of another sun. Hence it follows that on the outskirts of our system there may be regions of great extent entirely devoid of planetary bodies, for the obvious reason that as matter originates throughout these parts before natural operations have time to collect it into bodies of any size, it is and was during all past time being led by the rotation of the sun, which soon wafts it round to touch upon stronger attraction, thus becoming lost to the system. No doubt, on the other hand, our system in turn proportionately gains by new creation being wafted into it in like manner from the outskirts of neighbouring suns.

To explain so obscure a principle more clearly, let us observe that most likely matter in minute invisible atoms is being constantly generated, and we may reasonably suppose in about equal proportion throughout all space wherein material creation exists. In the outlying reaches of the sun's dominion these atoms, so soon as they exist, and no matter how minute they may be, are at the same time caught by the rotation and attraction of the sun; the former making them revolve and that at precisely the same rates as planets at that distance—for all matter, whether atoms or worlds, must revolve if within the precincts of a rotating body—the attraction drawing them nearer by gravitation. Every step that rotation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leads the atom in orbital direction wafts it nearer the confines of another sun, but its gravitation at the same time leads it sunward, giving it a chance of reaching the outer ring. If, however, before arriving at this haven of safety its revolving motion lands it into stronger attraction, it is, of course, lost to the system. In these outer regions, beyond the course of the last planet, it is thus certain no matter can permanently remain, and from the explanations given it is also self-evident to reflective minds that as it originates it is soon either carried hence into adjoining systems by revolving motion, or saved by gravitation within that charmed circle of our own where the planets roll, the atoms having in no case by the operations at work time to increase into larger collections of matter than perhaps the smallest ærolites.

These regions are therefore vacant, and as the same vacancies must meet from the outlying precincts of other suns, the systems within them being all circular, they—the systems—must be widely isolated from each other. It is thus clear that as system to system and sun to sun are related, vast intervals lie between in which there can be no worlds. Their dominions—although it is impossible to accurately define them and the relations that planets have to their suns—if studied in this comprehensive light, will better enable us to broadly grasp at the varied and intricate connection that the natural divisions of the universe hold to each other.

CHAPTER IV.

DISTURBANCES.

When attraction was first discovered it excited the attention of all thinking men as being the key to the government of the universe. By it they were at once enabled to give a reason for the gravitation of all objects; but it led them too far, for, believing that the tendency was universal, not only to objects but to the worlds themselves, the important question arose—How was it the moon did not fall upon the earth, the planets into the sun, and thus all creation become finally incorporated together?

Then there came the puzzling problems as to the weight of the bodies and their consequent motive forces. Taking the case of a stone, which, when thrown up, from its weight has an equal degree of motive force, it was naturally considered that the heavenly bodies being proportionately heavy, their motive forces, on account of their revolving velocity, must be past all conception. With the inconceivable force of motion the worlds must have, it was asked how were secondary bodies restrained from flying on interminable straight lines through the unknown? how were they, heavy beyond conception, the sun and stars included, and floating upon nothing, owing to their ponderosity kept from sinking out of sight?

These were grave and momentous queries; but they were solved by the happy idea of the experimental operations of a boy with his sling and stone. The stone, for instance, when slung round reproduces in miniature the motions of the planets, and the supposed motion of the sun, with a motive force in the stone, all complete. By its force of motion the stone is inclined to fly off, but the string holds it in, and the motion, so long as it is continued, saves it from falling. In like manner they suppose the planets and satellites are being thus continuously acted upon, and on a grander scale preserved from tumbling headlong from their positions.

They therefore conclude that the worlds are not only held up by these forces acting harmoniously together, but according to the same theory they are likewise held back from falling into each other. Objects, for instance, above the earth fall upon it, or rather, according to the prevailing notion, they both meet, and reasoning from such premisses it is concluded that by the same law all bodies, whether large or small, would thus meet, whatever distance there might be between them. The operation of the sling and stone, as we have remarked, solves the difficulty in a happy manner. The theory may be illustrated thus: The hand represents the sun, the string his attraction, and the motive force of the stone the same motion and supposed motive force of the planets, which would if not curbed in fly off at their tangents. These antagonistic forces are termed centripetal and centrifugal, it being laid down that they both, as opposed to each other, must be to the greatest nicety equal, and without which the whole celestial machinery would collapse; but as the force of the sun on the most distant planets must be next to nothing, and as their respective supposed motive forces are the same in all latitudes, how such a conclusion, as to the equality of the forces in all latitudes, is arrived at we have yet to learn.

To the same sling and stone experiment is due the idea of ruling and subject bodies mutually rolling round common centres of gravity. The operation in full demonstrates this to the utmost satisfaction. Thus the boy slinging the stone describes two concentric circles, an inner one by the hand, and an outer one by the stone held in the sling. The centre of the inner circle is the common centre to both forces, namely, the motive force of the sling and the strength of the hand. This they take as proof positive that all celestial bodies roll round common centres of gravity, wide or narrow, according to their relations and their differences in magnitude.

Doubt now upon the matter has ceased to exist, since it has been universally received as a truth, not theoretically, but mathematically proved—one of those heaven-born revelations, that to call it in question would stamp the ignorant querist with contempt. It might not, however, be scientific treason to ask the harmless question—Has a common centre of gravity ever been found betwixt the motions of any two bodies?

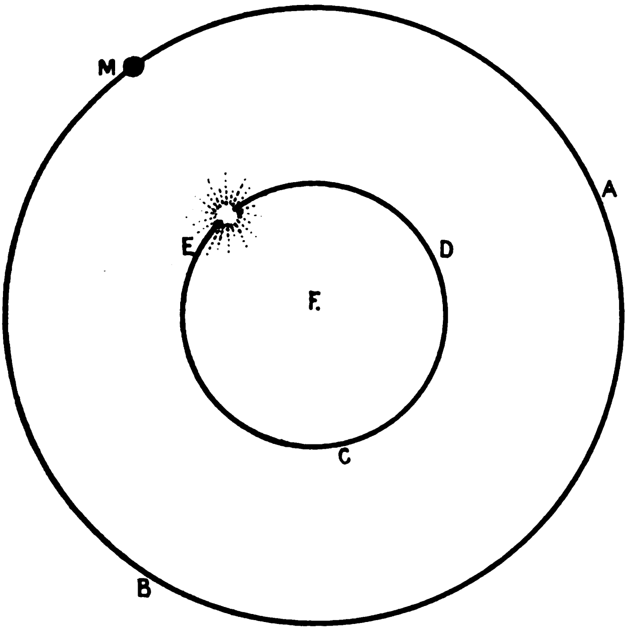
There is not a difficulty connected with the government of the heavens that the sling and stone has not cleared up, and whoever made the first sling was amongst the greatest of inventors, for its motions display within itself all the sublime laws given by the Creator to govern the universe and preserve the worlds from destruction. No wonder that its mysterious motions are taught in every school, and are held infallible in every college and university, and that as a scientific dogma it is received by the whole of mankind under the three names of centripetal and centrifugal forces, common centres of gravity, and disturbing causes. The three supposed forces reign supreme as a triumvirate, and are so linked and interblended as to form inseparable parts of a great whole. So indissolubly bound together are they that if one be true they must all be true, and if one is false so must the others. On them the great fabric of modern astronomy is made to rest, and how far they are true or false in our judgment we will illustrate by noticing the three in detail.

Beginning with common centres of gravity, we need hardly observe that it is universally held that no bodies stand still, but that they all revolve. Consequently, instead of the larger alone governing the smaller by their motions, they both mutually govern each other in an equal degree according to their magnitude, and by such mutual help the whole are supposed to be sustained in their positions. The sun, it is supposed, singly by himself holds up all the planets by giving them motion, while the planets in turn, in unison, hold up the sun, by imparting to him a corresponding motion, so that by one department of creation assisting another all are safe. The principle itself may be made somewhat clearer by the subjoined figure.

Let E and M be two bodies by themselves—the only two in a system—E, the larger, being the sun, and M the solitary planet subject to it. The planet is made to revolve round the sun E, by its rotation, while, according to the theory we are illustrating, E, the sun, is not permitted to stand still, but is made by the weaker force of the planet M to move round the more contracted orbit C, D, E; the common centre of gravity of both bodies being the point F in the centre of the inner circle, or, more properly speaking, the centre of both figures, because from F outwards all are concentric. The sun E, therefore, governs M, by making it describe the more expanded orbit A, B, M, while the planet M, in its turn, rules over its sun E by forcing it round the narrower orbit C, D, E, each of the two bodies being made to describe orbits, wide or narrow, proportionate to their respective magnitudes. Such is a faithful description of the relations that we are taught to believe all bodies in the universe hold to each other, whatever may be their complications; and it is by these mutual movements they are said to be, suns included, held up—notwithstanding their supposed enormous ponderosity—safely upon nothing.

Fig. II. illustrates our own ideas upon the government of the two bodies in question and their true relations to each other; and of whatever value our remarks may prove, we will now proceed to draw a comparison between the two theories.

We will suppose, as in the former instance, that there are two bodies only in a primary system, that marked E in our diagram is the largest and must be its sun, and M, the smaller, in subjection under it, as its planet. E, the sun, stands still in the identical spot in which creation first placed it—this fixity of position is what constitutes a sun, and not its luminosity—while M, the planet, would either stand still as a fixed body, or revolve as it might be acted upon. If E had no rotation, the planet, like its sun, would remain immovable, nor could the sun of any other system have any influence in imparting motion to it, because it is within the stronger attractive grasp of its own sun; on the other hand, the planet itself, if it had a rotatory motion, would have no power to impart revolving motion to its sun, for that would be a weaker force overcoming a stronger. Again, if the sun E had rotatory motion,—which, from the natural operations which originated this motion, we think is common to all bodies—its planet M would revolve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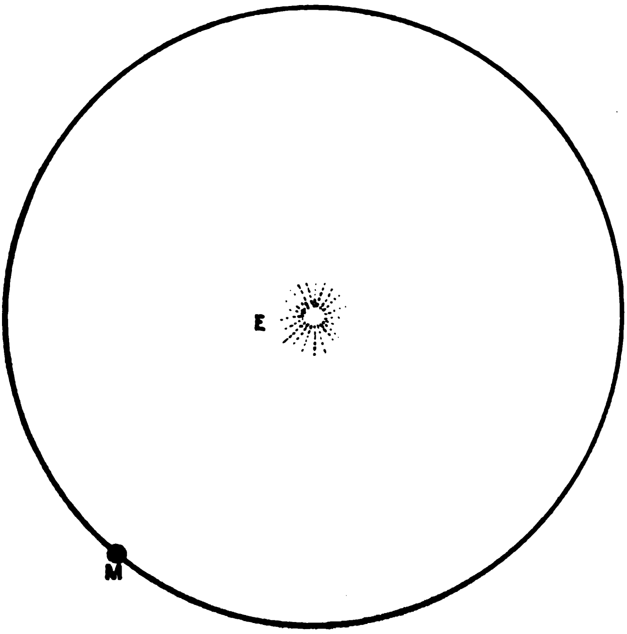
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round it from year to year, just as represented in the figure, the sun itself not moving a hairbreadth from its place by the action of the planet upon it, so as to produce the least imaginable common centre of gravity between them.

Such are our ideas of the relations of any two bodies together, whether it be the connection of a sun and planet, or planet and satellite. The governed body can have no influence, for if any such effects were produced, or rather if they had a common centre of gravity, such facts would have been long since demonstrated by the movements of the bodies themselves. From the first inception of the sling theory, it may be said, scientific men have taken it for granted that all bodies in their relative motions must have their common centres of gravity; yet strange to tell, they never pursued their inquiries farther in order to ascertain the reality of the phenomena. Had they done so, most assuredly they would soon have discovered that they were hunting a shadow, while their darling theory upon the least search after facts would have crumbled to pieces. If we only confine ourselves to the examples of the sun and moon, the question is settled and the theory exploded. Thus, all the calculations of eclipses that astronomers make, are based on the sun remaining fixed in his place, and their predictions to a minute proving correct should long since have established the fact that as a body he is permanently fixed in the same place, and that consequently no common centre or centres of gravity can in the minutest degree exist between himself and his planets, either singly or collectively. Subject to such influences, he would be continually shifting under the action of the separate planets, which, from their great disparity in magnitude, we grant would be but to a very limited extent. The earth and moon again are examples still more conclusive, for they form a system in themselves consisting of only the two bodies, the lesser one in subjection to the greater, as represented in Figure II. If we take the first of the two figures, what should we think of the author who published such an illustration of the movements of these two bodies? yet, however ridiculous, he would only be teaching in harmony with that which is received in every school. We are told that these two, as well as all other bodies, are mutually swayed in their revolutions. Here we give an example, proving beyond all doubt that, although both must keep company round the sun, there is no centre of gravity between them. The earth is never moved a hairbreadth from its orbit by the revolving motion of its subject body, the moon, acting upon it. Is it necessary, after such conclusive examples, to pursue the subject farther, more especially as we are only fighting with a shadow? All great astronomers for more than a century past have adopted the doctrine as if it were a creed. They have never found, however, nor will it ever be discovered, that a common centre of gravity exists between any two bodies, and failing such a grand but impossible discovery they must find some other natural cause for the worlds being made to hang upon nothing.

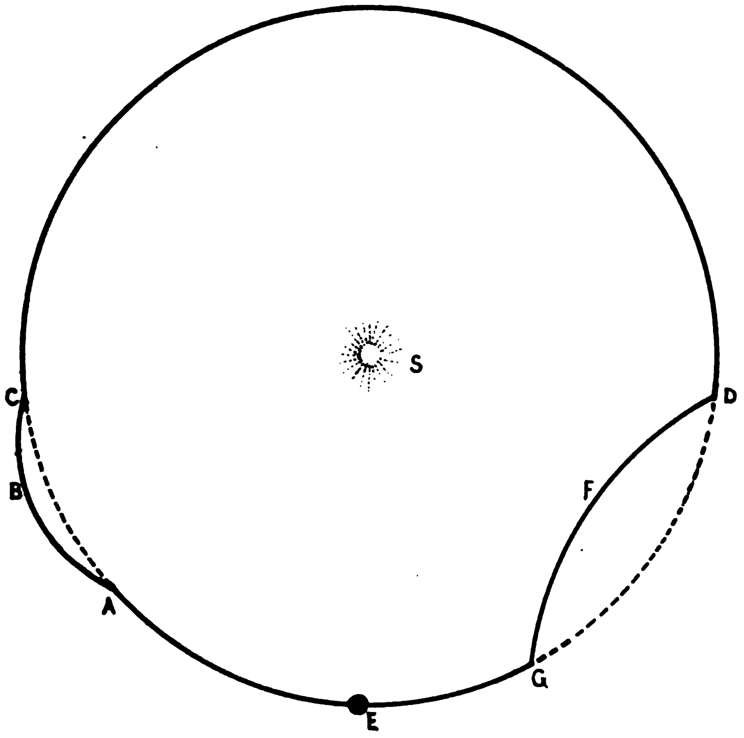
The inventor of the great theory of centripetal and centrifugal force had to take two principles for granted—namely, that bodies in motion have motive force,—such, for instance, as a stone when thrown,—only that their force of motion must be strong according to their greater magnitude; and that the attraction of the sun had to be equally strong in all latitudes in order to counterbalance the opposing forces, for otherwise should but a grain of difference exist between them, and this acting upon the bodies universally, their inevitable destruction would follow. As to their motive force we deny it *in toto;* but admitting that they have a momentum of motion, it could only proceed from their weight, which they generally admit must be inconceivable. Therefore, the force of their motions would be infinitely in excess of the attraction acting upon them, even in connection with the planets nearest the sun, and upon which the centripetal force must be stronger. Take as one example, Mercury, the planet nearest the sun. From the low latitude that this body holds, the sun must undoubtedly exert upon it a great force of attraction—or rather centripetal force; but supposing that it is heavy in the usual sense that the weight of worlds is considered, as a celestial body which moves with a greater velocity than any planet in the system, its motive force must be so tremendous that, near to the sun as it is, his attraction would be just as powerless to curb it in as the action of a magnet on the motion of a cannon-ball. Again: the momentum of motion, if there is such a thing in non-gravitating bodies, must be according to the magnitude of the body, equal in all situations whether near to or remote from the sun, whereas his attraction or centripetal force weakens as to distance. Now, granting for the sake of argument that the two opposing forces in this one case of the planet Mercury are equal, they cannot possibly be so in relation to any of the other planets; for being all at greater distances, the sun's attraction or centripetal force is weaker and weaker on each as it becomes more remote, while their motive force, if such a force in the heavenly bodies is possible, must be still the same, in whatever latitude they may be. The planet Neptune may be taken as an extreme case. The attraction of the sun on that body must be in a vast degree weaker than on Mercury; and the motive forces of both bodies, according to their magnitudes, being equal, it therefore follows that it would be an absurdity to conclude that the centripetal and centrifugal forces on both are equal. But granting that at Mercury both forces are equally strong, at Neptune the centrifugal force must at least be hundreds of times stronger than at the other; and the same reasoning, although in not so extreme a degree, applies to every planet in the system. If the two forces are equally balanced in regard to a single one, they would be of necessity unequal on the others; and as the decreasing strength of attraction, according to distance, proves that this must be the case, some other principles than these imaginary forces should be looked for as the preservers of the universe.

We may now, lastly, enter upon disturbances—one of the three principles upon which modern astronomy is based. That which is understood to be a disturbance is the united attraction of all the bodies of the heavens on one side pulling, as it were, a body in opposition to a contending force in the opposite direction. Whenever it happens that one of the two opposing forces is stronger than the other, the body acted upon is supposed to be drawn out of its proper position a distance corresponding to the extra strength of the stronger. Disturbances, if they exist, must therefore affect all bodies in a greater or less degree. It is also characteristic of disturbances that they are irregular as to time and place, and from the changes in the positions of the opposing forces no two disturbances on the same body, as they succeed each other, can be in all respects equal. Planetary motion so changes the relations of all the forces, that the same exact measure, very likely, could never be applied to any particular body a second time. If, therefore, disturbances were possible, they would produce an infinite degree of irregularity in the movements of all governed bodies. Indeed, it is generally admitted that this was so during the earlier ages of creation; but they conclude that the disturbances in time, by natural operations, were enabled to mould their movements gradually into such a degree of harmony that days, nights, seasons, and even years, might follow in succession without change, notwithstanding the disturbing causes being in constant operation upon them. Or, to explain the reasoning more clearly, they suppose that in the existing settled condition of the system, the disturbances only affect bodies indirectly, by causing them to run on orbits more or less circular, according to the measure of disturbance each body on the average is liable to receive.

It is strange that disturbances are never inquired into excepting in instances where the sun is taken as one of the two disturbing forces. The very possibility of such phenomena occurring from other directions seems to be ignored, and yet the material causes that are supposed to produce them exist, at least numerically, about equal from all points of the sphere. If it could be shown that disturbances were only possible on the plane of the orbit, a plausible case might be made out in support of the venerable doctrine, seeing that all known orbits deviate more or less from the circle, whereas were it not for the perturbations of the past, it is held that all such figures would by nature be perfectly circular. This specious conclusion, however, at once breaks down when we come to view the many directions from which a body may be disturbed. Works upon the subject only treat of two directions from which such phenomena can take place—to and from the sun—but there are as many other directions as points surrounding the body supposed to be disturbed, no matter to what points from a planet we turn; but all matter is considered, however feebly, to disturb it, and there are in the contrary directions similar forces. Hence disturbances should not only twist right and left on an orbit, but up and down, and indeed in every possible direction; and if these effects are not or cannot be shown to have taken place, we are justified in accounting or rather looking for the eccentricity of orbits from other causes. We need scarcely add that it is known to all scientists that orbits, if they are not circles, always lie on the same planes—a proof, mathematically certain, that in any possible direction in which the sun is not an opposing force, no disturbances ever happen, and therefore as such irregularities are known only in a lateral direction, it completely overthrows the only argument in favour of the theory of disturbances—namely, the eccentricity of orbits.

The principle of equally balanced forces is in a sense taken for granted in disturbances, the same as in centripetal and centrifugal forces, and with results just as illogical; but it must be admitted that if the near equality of the forces on the average are not taken for granted, the theory would not have a scintilla of rationality to uphold it. If the disturbing causes, taken on the average, are unequal, the bodies acted upon must be gradually pulled either into the sun or disturbed farther into the system, and in the end lost in the unknown. Mercury, which is supposed to be scorched into white heat by the sun, would in another epoch be wandering through the chilly regions of Neptune, while the latter during the same period might be gradually disturbed into a warmer solar latitude. Thus is presented the anomaly of all the bodies in the system constantly changing their proximity to the sun at the caprice of the disturbing forces. In short, according to such teaching, disturbances would long since have either buried them in the body of the sun, or sent them into infinitude, were it not that they met the difficulty by taking the principle for granted that all the opposing forces are, on the average, nicely balanced. Under this providential prevision they comfort themselves with the idea that all bodies are permanently held in their respective positions in inviolable safety.

If disturbing forces did not counterbalance each other, the theory would of course break down. Its weakness consists in the fact that the leading principles are all taken for granted, and not one of the intellects who have held the doctrine to be infallible have ever yet pursued the inquiry whether or not these supposed disturbing forces were, as opposed to each other, equal. Had a single thinking mind but considered the question, it must have struck him at once that the sun being one of the forces, at least in lateral disturbances—the only disturbances they ever think of—the preponderance of force in all cases must be vastly greater in that direction. On the planet Mercury, for instance, his attracting force in unison with the bodies on the same side must always be millions of times stronger than the attraction acting upon it in the opposite direction. The balance of the opposing forces no doubt becomes less in their action on more distant planets; but if taken in detail, even as regards the most distant planet in the system, it could be easily demonstrated that the disturbing force in the solar direction must still immensely preponderate over the combined attraction opposed to it. With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such examples before us, we are enabled unhesitatingly to pronounce that disturbances can nowhere exist, nor have they ever taken place. If it were possible that bodies could be so agitated, the very nature of the case proves that the vast preponderating force would always be on the side of the ruling bodies; and this, we need scarcely add, would very soon consign all subject bodies into their suns. The work of destruction would not end here, for as the suns themselves differ greatly in magnitude, the larger would draw in the smaller, and thus the sparkling luminaries, which like so many gems adorn the heavens, would be blotted out. He who made the universe and bade all things exist never so imperfectly constituted His created works that one could thus destroy or disturb another. He has implanted harmony throughout, and subjected them to laws, beautiful in their sublime simplicity, by which they are self protected in imperishable safety.

We cannot yet part with the subject without explaining more minutely how disturbances are supposed to act on bodies, and this we will do by means of the subjoined figure, which represents the sun in the centre, and the earth describing its orbit in subjection to him.

Two disturbances are shown to have taken place during one of its annual rounds, one A B C—a planetary disturbance, and the other D F G—a solar disturbance. In plainer terms, one takes place by the force of the sun drawing the earth nearer, and the other by the attraction of exterior planets in opposition to that of the sun, so far drawing it out. The earth in passing round its course, had it been free from perturbation, would have moved along the dotted lines, its true orbit, instead of on the curvilineal directions the agitating causes led it. Moving from E, we will take for granted—rather difficult to do, as disturbing forces must be more or less at work wherever a planet may be—that it continued on without being disturbed till it reached A. On arriving at this point, Mars and Jupiter happened to be in conjunction with the earth,—an extremely rare occurrence,—and they together formed one of the most powerful planetary disturbing forces that at any time could affect our planet. Their united attraction being more powerful than that of the sun, as the stronger force, although not a ten-thousandth part—mark the logic—they began to pull the earth in their own direction at A, and continued to bring it nearer and nearer, and in the same degree farther from the sun, till it reached B. Here the sun, notwithstanding the greater distance it is removed from him, while the planetary force is in the same measure stronger, begins to gain upon their opposing attraction until he is finally enabled to restore it back to its proper orbit at C. We will not inquire why the same attractive force brings it no nearer than C, although his power must be stronger upon it in the nearer position. Continuing to run its orbital course from C to D, if disturbances were possible, it would be agitated at every step, either to or from the sun; but let us suppose that the solar attraction began to gain the ascendancy with nothing in opposition, and continued to draw our planet dangerously nearer till it reached F. This gravitating tendency was ominously perilous, and had it continued much longer, the earth would have narrowly escaped falling into the sun. To continue our supposition, we must believe that at the right time a friendly planet—perhaps an asteroid—came into conjunction, and that acting more powerfully upon it than the central force—a pin head opposed to a cannon-ball—it was gradually drawn back out of the grasp of the destroyer to its legitimate position at G. Thus this second disturbance came to an end.

The foregoing is a very fair description of a solar and planetary disturbance from whichever direction it takes place; and however ridiculous the explanation may be, it is a faithful illustration of what is universally taught. Might it not be worth while to inquire, Whether or not the earth has ever been known, as in the figure, to move with irregularity, or to be disturbed or led off its orbit in the least possible degree? Nay, we will go farther. By searching into the history of astronomy for centuries past, and examining the thousands of calculations and measurements that have been made during that time, we shall find that no disturbance, not even to a hairbreadth, has ever been known to take place either on the orbit of the earth or that of any other body. And as the truth of these historic records is confirmed by the simple calculation of the eclipses therein mentioned, we know with mathematical certainty that at least the sun, moon, and earth for that long period, over which these extend, were free from perturbation. It is only on such supposed absence of disturbing influences that eclipses can be predicted in the future, or calculated back in the past. Again, we find by the transits of Venus and Mercury that they in like manner are not disturbed in the least degree. If they were, like eclipses they could not be foretold; but these recurrences are marked down to a minute, the calculations resting on their going round in exactly the same times and on the same threads of space permanently undisturbed. The moon in like manner is never disturbed, for she is eclipsed at the exact times calculated, and by the same or kindred observations, the moons of Jupiter are found never to be acted upon by disturbing forces. Finally, taking the planets Mars, Jupiter, and Saturn, it might be demonstrated with the same degree of certainty that they perform their revolutions with the regularity distinguishing the others, and the times when any of them come into conjunction with the earth, or are to be occulted by the moon, or pass over the lights of particular stars, are events that when calculated are in all cases fulfilled at the exact times foretold; such conclusive examples, we submit, should for ever settle the question, extending as they do from the present back by historic records to remote antiquity, including the movements of all discovered bodies, and the thousands of calculations made by modern astronomers—the whole forming a vast collection of mathematical proof that it is impossible disturbances can happen. If we could at will seraph-like traverse the universe and find every created body to be equally free from disturbing causes, the facts could not be more telling. They demonstrate to a certainty that at least all known bodies describe their orbits round the same threads of space without deviation, never changing—if they are bodies of perfect mould—a hairbreadth from their allotted lines in their annual rounds. There can therefore be no doubt the principle applies to all creation.

Laying aside such convincing facts, we may in the next place ask the question, Has a single disturbance in connection with any planet or satellite during the history of astronomy as a science ever been discovered? We fearlessly reply that no such phenomena has ever been known. Yet the whole of mankind believe in it—a phantom, a thing of the imagination—and on this visionary basis they have reared up a huge fabric of false philosophy, an incubus upon a glorious science, one above all other studies which delights the soul and enlarges the intellect. They have built up their theory also in the face of the thousands of calculations they are constantly making—all founded on the basis that it is impossible that disturbances can be, and notwithstanding this they still cling to their pet theory with unswerving faith, although, as we have said, their works and studies continue to add volumes of proof that no body in God's creation can ever disturb another large enough to be an attractive centre.

The varied eccentricity of orbits, as previously observed, is invariably taken as the strongest possible indirect evidence of disturbances at a remote period having produced irregularities, which it is supposed time gradually moulds into harmony, leaving the orbits to repeat themselves without variation in the respective shapes thus finally imposed upon them. This is but the fallacy repeated of taking a principle for granted to support a supposed truth. We hardly dare venture to reply from our own view that the figure of an orbit conforms to the shape of the body which describes it, as we have not sufficient data at command to lay 'down such a conclusion as a finality. We must, therefore, simply observe that no orbits, however eccentric, ever vary, if described by bodies of perfect mould, and thus in themselves as examples form a common protest against the theory. Besides, we think it is incumbent on the supporters of such theories, first to prove the existence of disturbances by some one solitary instance before they proceed to attribute the eccentricity of orbits to causes which so far as discovery goes are purely imaginary.*

We have repeatedly asserted that no disturbance in any age or time has ever been traced to any independent body; and that our position may be left unassailable, we are in the last place forced to notice a historic incident, the only instance on record, which gives—apparent—direct proof of planetary disturbance. The discovery of Neptune is the incident referred to. But before relating the particulars, we must briefly refer to a law of planetary motion universally known, namely, that the position of the sun is always nearer one end of an orbit in the same degree as it is oval, consequently the planet describing it in approaching its aphelion —the point of the orbit farthest from the sun—its distance from the ruling body gradually widens for the full half of its yearly round, up to that point. Except in the cases of bodies moving on circles, if any, this is the condition of all governed bodies—they increase their distance from the sun on one half of their respective orbits, and in an equal degree lessen it on the other half, as they approach the perihelion. Some one, when the celebrated disturbance to which we have adverted occurred, took an observation. Great was his surprise to discover that Uranus—for it was to that body the observation was directed—had wandered farther out from the sun; but to no greater extent than other planets, such as Jupiter and Saturn, whose orbits are considerably more oval, do under like circumstances. The important fact was, of course, duly chronicled, and it naturally set the astronomers of Europe in a ferment. To account for what was to them a wonder, although more or less common to all the planets, they had recourse to their favourite theory of disturbances, and thus several eminent men in different parts simultaneously concluded that some planet must be lying beyond, and which, according to the reasoning, was dragging Uranus out, by its attraction, with a stronger force than *that of the sun*, in opposition. They looked out for the supposed planet, and by more than one observatory Neptune was at nearly the same time discovered—a remarkable coincidence, seeing that there were a hundred chances to one against the two planets being at that particular time in conjunction; but it is so happened that both were nearly on a line. Thus with the exception of marking out the relations of the double stars by Herschell, the greatest astronomical discovery of the present century was, as it were, blundered upon by a universal belief in one of the greatest scientific errors ever taught.

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* The vagaries of comets are in like manner looked upon as almost proof positive of the reality of disturbances. We intend to devote a whole chapter to comets, in which we shall treat upon the apparent anomalies in their government in detail, and if what we there advance be true, nothing connected with this singular class of bodies can be in the least degree owing to disturbances.

For a lengthened period after the discovery, Uranus still continued to recede till it reached the remotest point of its orbit from the sun, just the same as other planets do. Nearly all these years Neptune was left so far behind that he could have had no effect upon Uranus; and we are not aware since then whether the whole of the circumstances as they occurred have been made known. Has it also been considered that there was an interval between the two planets—the disturber and the disturbed—of more than a thousand million miles, or to make it plainer, ten times the distance of the earth from the sun? With such a great interval between them we are inclined to think the disturbing power of Neptune must have been infinitesimal, and vastly weaker than the opposing force of the sun.

When the discovery was made it was rightly considered a grand achievement, seeing that at a bound, as it were, it more than quadrupled the cubical extent of the system. Its greatest value, however, in the eyes of eminent men, with their erroneous views on the vital question, was the solitary proof it gave of disturbing causes. This was to them most important, seeing that they have made astronomy, as a science, to rest principally on that theory. We venture, however, to question very much whether it was right to mark this down as a disturbance, it being the first time that Uranus was ever seen from the earth to pass round that part of its orbit. A disturbance, correctly speaking, is a supposed irregularity caused by the body being drawn by interior or exterior force out of its beaten track. It could only be called an irregularity if the phenomenon is not repeated half a century hence, when Uranus will be once more on that part of its orbit. Then, and not before, can it be put down as a disturbance. But the astronomers of that day will find it go round the same thread of space even to a hairbreadth. Neptune will not then be in conjunction to account for it, and if it be a body of perfect mould—and we may reasonably believe it in this respect to be the same as most of the other primary planets—its revolutions will describe the same figure in all time coming.

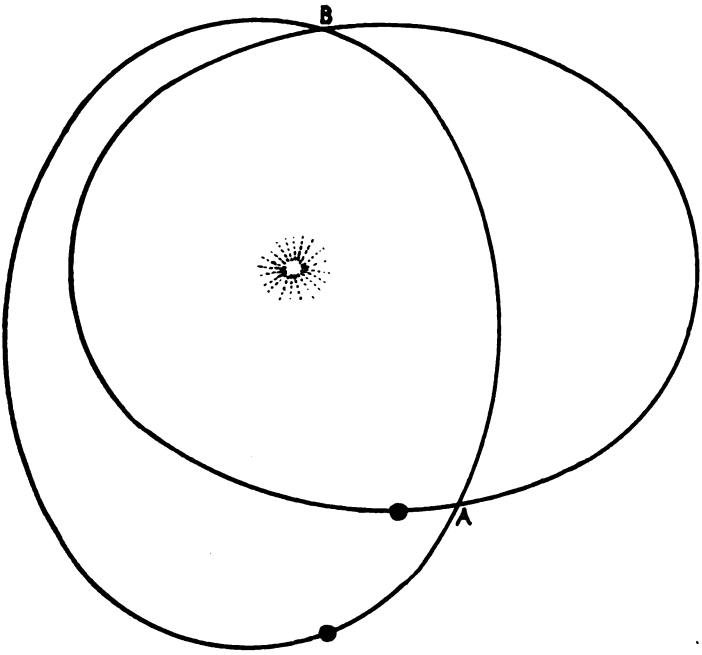
CHAPTER V.

GATHERING TOGETHER OF SECONDARY SYSTEMS.

WHEREVER we see common effects produced, they are in all cases traceable to known or unknown natural causes. The planets revolve, and there must be a cause for their motions. The cause is the sun. They go round in one direction, and lie nearly on the same plane—all common effects in connection with their motions—and we naturally ascribe them to the same body; reasoning likewise upon the facts, and comparing them together, we also obtain incontestable evidence, from the whole range of human discovery, that the wonderful results proceed simply from the sun's rotatory motion, thus establishing the fact that rotatory motion rules the universe.

The revolving motions it imparts to bodies, although secondary and subject motions, have produced results in time past, if not more wonderful, at least vastly more useful than the primal motions that guide them. In short, rotation may be put down as the action that rules the universe, and revolving motion as that which has modelled creation, and built up all the heavenly bodies, excepting suns. Without it as a motion, no secondary or governed bodies could have existed, and by its operations the materials that through long periods of time have gone to make them up, were held back from gravitating into the sun. These, it should be noted, are not operations of the past that have ceased; they still continue in full force, holding back a moiety of creation as material for planetary construction, the remainder going to the enlargement of suns. We also owe to revolving motion that planets were made to assume the globular form, and by it bodies were collected into groups or secondary systems, and by the same agency likewise, Saturn was surrounded with rings. All these common effects, produced by revolving motion, we will treat in detail under their respective heads, beginning, in the present chapter, with secondary systems, or rather a description of the operations at work which collected secondary bodies into clusters, instead of their being scattered indiscriminately over the area of the system in the positions where nature may have at first placed them.

It will not affect the soundness of the general principles in view if we set out with the orthodox idea, although very wide of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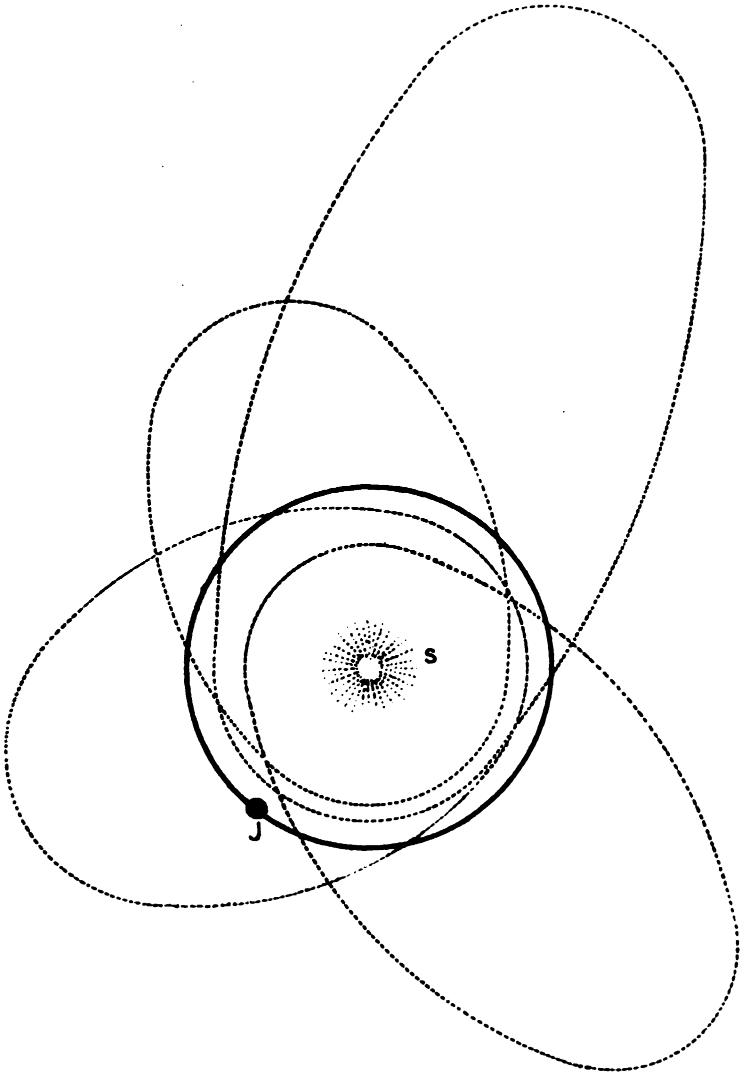
the truth, that at first all the bodies of the system were full grown, but that instead of being brought up nearly on the same plane as we see them now, and collected apart into groups, they were, according to the ordering of Nature, distributed indiscriminately throughout the expanse of the system, some being nearly equidistant from the sun, but all widely apart—north and south, east and west, according to their primal positions. They were not then on the plane alluded to—the plane that coincides with the sun's equator and which they all now lie nearly upon—but in extreme cases, we may reasonably suppose, some of them may have been lying almost at right angles to his rotatory motion. From their several positions, however, in course of time they became deflected, and that gradually to that great plane round which they all now revolve, those that are lunar in common with all the others being as yet independent planets. When once inclined by the rotation of the sun up to this position—indeed to a certain extent earlier, as all orbits differ more or less in eccentricity—those amongst them differing but little in mean distance from the sun had their orbits, by reason of their variation in figure, intersected. All bodies that are now moons were thus related, and through their motions cutting over or near the paths of such planets as were destined to become their primaries, they gradually overtook or were overtaken by them. As these events followed, the smaller, one after the other, which were by nature constituted to be in a lunar state, gathered in course of time around the primaries in their different latitudes. Thus our secondary systems were formed.

So far as is yet known, it is only the major planets—Jupiter, Saturn, Uranus, and perhaps Neptune—which rule over secondary systems; excepting the earth, the largest of the minor planets,—this being the only discovered system with but one subject body within it. Let us by means of the figure which follows help to explain the natural operations which brought this solitary subject body under terrestrial rule from the condition of an independent planet, as all satellites in their earliest condition were.

At first, both bodies, in their relation to the sun, if they described the same shaped figures as they do now, must have been nearly at the same mean distance, but by reason of the difference in the eccentricity of their orbits, and a still more important quantity, the position of the sun in relation to each orbit, they crossed, or rather intersected each other at the points A and B. They both, in obedience to the sun, like the other planets revolved from west to east. One of the two having a shorter year than the other, being in the mean proportionately nearer the sun, at long intervals they overtook each other, and thus came into conjunction. The periods between these conjunctions were long or short, according to the difference in their years. Their repeated conjunctions must likewise have taken place at different points, each conjunction in succession coming nearer one of the intersections than the last. Eventually a conjunction took place near the intersection B; but the two, as planet and moon, did not then become united, simply because at that important position the smaller planet was not led close enough to come into subjection to the earth out from under the direct government of the sun. To come within terrestrial rule, it was indispensable that the conjunction should take place so near the point of intersection that the planet about to become our satellite would be more within the attractive sphere of the earth than the surrounding predominant attraction of the sun, and, these essential conditions not meeting, they for this once slipped from each other. An equally long period, therefore, had to elapse before another chance would occur of bringing the one planet into subjection to the other. The work had to be repeated again and again of conjunctions following each other, till at last one took place at or near the intersection A. Once more they were liable to escape and remain an equally long time unlinked together; but from the relations of the two orbits the union was at one time or other inevitable. They were sure, at some period, when a conjunction took place at one or other of the intersections, to be sufficiently near each other, and when this did happen the smaller of the two planets became subjected to the larger as its moon.

In approaching the intersection A, if the conjunction happened exactly at that point, they had only each to revolve a short distance to collide, or rather run straight on each other, an event which, from the nature of the question, could seldom or never come about; yet there would be no collision, for as soon as the smaller dipped deep enough into the attractive sphere of the earth, when reaching the proper distance for its secondary subjection, it would begin revolving round its new ruling body, in obedience to its rotation, just as it was previously guided in its planetary state by the rotation of the sun. In short, its own revolving motion led it to be caught within the charmed sphere —infinitesimal compared to the extent of the system—wherein the earth is the centre of attraction. When once there she had to yield obedience to it as the attractive force acting most strongly upon her, and for ever submit to it as her new governing body. So soon as she was caught under secondary rule, she could never escape out again under the direct government of the sun. Small planets, wherever they may be, if they intersect the orbits of large ones, when they become so changed as to revolve nearly on the same plane, are sure one time or other to be caught, and if they have quicker rotatory motions than the larger, it is their fate to come into collision and be incorporated with them. They may be spared in a lunar state, but never can they regain their former condition. Planets, if so related, may fall into lower subjection, but satellites cannot regain their primal condition. It is possible that bodies may sink into lower subjection, but they can never rise higher.

The subjection of the moon to the earth is but a single instance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of an independent planet being reduced to secondary rule ; it is therefore necessary, so that we may have a more comprehensive view of the formation of secondary systems on a larger scale, to have recourse to Jupiter. And with the assistance of the following figure, we will explain how he and the four planets, that were destined to become his moons, may have been at first related. It is, of course, impossible to mark down their actual primal relations, but whatever their orbits or movements were, they must all at least have intersected, or at some points come near in their movements the orbit of the greater planet they were some time or other to come under, so that, in whatever manner they were related, the inductions will rest upon the same general principles.

S is the sun in the centre, J is Jupiter revolving round the dark line, its orbit, and the dotted ovals are what once were the orbits of the four planets, now reduced into a lunar condition under him. In one sense the planet had no very tedious difficulty in laying hold of these bodies, on account of his very wide attractive sphere, but viewing the question in another light, under any circumstances long periods of time were likely to elapse before they were severally satellised.

The wide sphere of rule over which Jupiter's attraction prevails may be fifty million miles in diameter. It may even be less or considerably more, as reliable facts are not forthcoming by which we can determine the extent with even the vaguest certainty. This we know, that the area is of great expanse, and is carried along with the planet, and slightly varies in breadth according to the nearness of the sun on the different parts of its orbit. Throughout its annual rounds, all planets or planetoids, whose orbits at any points even touched upon that wide circular belt of space, were during the course of time either incorporated with or satellised by the planet, and that no matter how numerous in the long past they may have been. In the earlier stages of creation, the planetoids were no doubt of a much smaller class than the moons, and thousands in number; but for the present we have only to do with the four planets that at different times in the past became subject to Jupiter as satellites. These bodies, when in their primal condition, may have been in the mean considerably more remote from or near the sun than their future ruler; but on reflection, it must be evident that, from the wide diversity in the figures of orbits in general, at some points the orbits of these small bodies, taken separately, touched near to or intersected that of the great planet. Every time one of them came into conjunction with it a chance occurred of losing its primary condition, but when the conjunction happened to be so near the intersection —perhaps no less than twenty million miles from Jupiter himself —as to become buried within its attractive sphere, it was at once satellised in the same way as we have described the subjection to the earth of our moon. In this manner all the four were in succession caught, at times no doubt widely apart, but when once brought together, they, with their primary, constituted one of our secondary systems.

If we go to Saturn and Uranus, they likewise have their systems, and it would be but a repetition to describe their formation, seeing that precisely the same natural operations collected their moons as those by which the earth and its attendant were brought together, and which also constituted Jupiter and his satellites into a system. It may, however, be objected, in thus accounting for the formation of secondary systems, that we are taking principles for granted, and on these resting great conclusions—namely, that the bodies which are now satellites were once planets, and that while in this higher condition their orbits not only mutually intersected, but, what was essential for their subjugation, trespassed upon the paths of their future primaries. If they had been planets when in that state, they must have intersected. Being so nearly on a common plane there was no room for their orbits—all very eccentric as we shall have reason to show—to play free of each other. More especially was this so in connection with Jupiter and the other primaries.

That they in reality were at first planets instead of what they are now, grouped together in a lower condition, there can be no doubt, as the grouping is that common effect, which in every department of creation unmistakably tells us that natural operations produced them—except we are to take the irrational view, that the bodies of the system came from the Creator's hands at the same instant, and in their present perfection, rounded in form, and collected here and there into families of worlds, exhibiting as a whole mechanical order and mathematical nicety. Our early training certainly coincides with this latter view, but the more rational answer would be, that, being common effects produced incontestably by Almighty design, the grouping of worlds together, modelling them into perfect shapes, and such like, must have resulted from natural causes, and not from a creative fiat that commanded perfection at once to exist. No reflective mind would adopt such a theory: and it being therefore granted that the satellites were not at first clustered artificially together, they must have been scattered throughout the system, as Nature placed them, solitary by themselves, and for a time out of reach of secondary control, small though they might have been. There is little doubt but that they were then insignificant and small—we are dwelling on a time when creation was young, and all bodies were on a much lower scale of magnitude than now. So situated, they must have all been independent planets, each one going round its own orbit; and from their varied degrees of eccentricity—far greater than at present—together with the position of the sun in relation to each one, there would at that period be intersections innumerable. It was through these intersections bringing the bodies by their motions into near proximity that any of them were satellised, and without which no secondary system could have ever been formed.

Let us now look at the question in another light, and imagine all the bodies of the system to be scattered, by Almighty power, indiscriminately throughout the dominion of the sun. From such a chaotic state the operations at work would in time again reduce them into secondary systems of different combinations, but much the same as they now present themselves. The rotation of the sun would at once set them all revolving round him in one direction, and the work being thus commenced would in time—after the lapse of perhaps millions of years—gradually bring them into clusters, in the manner described. At the outset they would of course be independent planets rolling round the sun, but eventually they would be inclined by his rotation to a common plane, where there would be insufficient room for so many orbits to move free of each other. Of necessity, then, they would cross and re-cross each other at many points. Being nearly all thus confusedly related to each other, whenever any two of them by their revolving motions came, as we have described, in sufficient proximity to the intersecting point, they had either to collide and be mutually incorporated, or the smaller of the two become subject to the larger as its satellite. The larger, with its new attendant, would still continue as before to revolve, and such other planets or planetoids which at any time during their revolutions only touched the circular belt of space traversed by the attractive sphere of the larger, would, whenever caught, either fall into it or be permanently attached as satellites. These changes would continue to take place so long as one of the scattered worlds crossed the orbit of another; in the end leaving them clustered together into groups of worlds, such as they are at present. And it was the same operations—still continuing in full force—that in the long past gathered together into their several combinations our secondary systems, formed Saturn's rings, and gradually swelled out at least three of our four major planets so vastly above the others. The causes of their great size, and the enormous preponderance of the sun, could be as clearly accounted for as any subject connected with astronomy, but both are questions which it would be out of place to enter upon here.

If the formation of secondary systems is now completed, that is, if all the insignificant and perhaps invisible class of asteroidal bodies throughout the system intersecting the orbits of the great planets are by reason of their revolving motions incorporated or appended as moons, the antiquity of such a stage of creation must be vastly remote. This may be exemplified by the probable time which passed in bringing the earth and moon together, even after taking for granted the fact that their orbits from the first lay nearly on the same plane—the most favourable of all relations for a speedy union of the two. Besides, these two bodies also were more likely to come together sooner than moons in more remote secondary systems.

When they were both primary planets, with their orbits intersecting each other, it is evident that if they were then as perfect in shape as at present, their mean distance from the sun was nearly equal, as their orbits must have been of the same figures they still are, and consequently in their years there was but a slight difference. Had their years been perfectly equal, their mean distance from the sun would have been equal; their orbital motions, averaging the year round, would have been also equal, and even supposing both moving on the same orbit—a relation that never yet existed—no union could ever have taken place between them, for their uniform motions would for ever keep those intervals of space separating them unchanged, as they would have been on the same track running a race of equal speed. However, as such an equality in rates of motion and exact distance between any two bodies may be looked upon as impossible, there must have been some difference in the years of our earth and moon when both were primaries. What that difference was can never be known. It may have been only a single hour, it may have been a day, or, taking a more extreme view, it may have been a week or as much as a month; but whatever the difference may have been, the shorter it was, in the same degree it took a longer time for both bodies to come together, and, on the contrary, the longer the difference in their years the union was liable, but not certain, to be brought about in a time proportionately short.

If we suppose the difference which existed in their respective years as a day, and beginning with the first conjunction of the two bodies with the sun immediately past intersection A, their next conjunction would be at the end of 365 years, and it would take place exactly at the distance of one day's motion on their orbits in the direction of B, from the position they held at the preceding conjunction. Another equally long period had to pass before the next, and they had to follow, one after the other, in successive equal periods, till at last one of the conjunctions took place at or near the intersection B, the first chance the two planets had of being united, the one in subjection to the other. They would come into conjunction with the sun 182 times before the event at B could be fulfilled, and these figures multiplied by 365 gives a total of 66,430 years—the shortest period within which they could be united as planet and satellite, allowing the length of a day in their primal state to have been the difference in their years. Again, if the original difference in their years had only been an hour, the time taken in bringing them together would be twenty-four times longer, or more than one and a half million years. Finally, with a week or a month's difference—the latter an extreme view of the case, but it was possible, making allowance for the relations their orbits might be in—the event with the former difference in their times may have been accomplished in 9490 years, and in the latter in about 1600 years. We say may, for a week or month's difference would so much widen the points of conjunction, as they followed, that there was a liability of the intersecting points being missed, so that the latter two numbers with such a difference in their years were likely to be repeated more than once before the two bodies would be united. Even with these relations, no matter how often they might be enabled to escape each other at the intersections, the frequent repetitions would, in the end, lead them into proximity near enough to be wedded in bonds which would bind them together while they existed.

With regard to the other secondary systems, the time which must have elapsed during which they gathered their moons together, supposing the work to be completed, may have taken millions of years; but the period in reference to each satellite, as in the case of the earth and moon, and in the sense that the orbits had no great leaning from each other, depended upon the difference in the year of the planet, compared to that of the body about to be satellised. If we, for instance, take the moons of Jupiter, each one of these when planets, as they could not have differed much in mean distance from the sun with their primary, —we are reasoning on the false principle that we were forced to take up at first, that creation at the beginning brought them into their present state of perfection as bodies—must have had their years proportionately equal; but in one case, as compared with another, the difference must have varied widely in the sense that a day differs from a year, for there may have only been a day of difference compared to Jupiter's time in one case, and a year in another. To avoid the weariness of figures and the calculation of supposed conditions we will not speculate, as we have done in regard to the subjugation of our moon, upon the lengthened periods these satellites may have remained primary planets; but by a careful study of the subject we gain a comprehensive idea of the immense time that may have elapsed during the formation of secondary systems, if they are, as to the subjugation of the last of their moons, all perfected.

The foregoing remarks as to lengthened periods which planets, or, more properly speaking, asteroids may remain free before being satellised, only apply to such whose orbits incline not too much from the same plane, or that revolve at nearly the same mean distance. If otherwise related so that they had such a leaning on their orbits, as not at any points to touch on the belts of space swept round by the attractive spheres of the great planets, their secondary subjection would continue impossible, until in the course of time natural operations so modified their relations that in the end they were brought under. Such mysteries cannot here be entered upon. It must suffice for us to briefly observe, that there were indirect hindrances which may have prolonged the period—at least of the more remote secondary systems—from being perfected for perhaps many million years. It might also be a nice question whether or not the last of the little planets, or asteroids, which are eventually to become additional moons—as yet independent and too small to be visible—

are still pursuing their courses in humble solitude round the sun.

When speaking of small bodies which we fancy may exist in the latitudes of the great planets, but which are unknown, we cannot help referring to one belt of the system, wherein creation appears little advanced beyond its primal condition. We refer to the region of the asteroids situated between the orbits of Mars and Jupiter. Considerably more than a hundred of these little planets, known by the general name of asteroids, lying over that division of the system, are already made known. They range from one body about a fifth of the size of our moon, down to objects so minute that at this distance they cannot be measured; and from the nature of the subject it is certain that many of them are yet to be discovered. Also it is unquestionable that through that region, an innumerable class exists, so small that they cannot be seen—small planetoids which only rank in the next creative step above the largest aerolites. This host of planetoids and asteroids must have their respective orbits, which, if it were possible to trace them, would present a medley of many thousands of intersections—a great irregular network of intersecting lines. Amid the innumerable orbital crossings of these asteroids and planetoids they must collide, and, if they differ to a certain degree in magnitude, are mutually incorporated; thus, there is one orbit less for every collision. The unseen work, therefore, goes on progressing, the smaller from time to time becoming incorporated with the larger, and the latter in turn being absorbed by yet larger, until in the course of time, possibly millions of years, they by their motions will all inevitably be collected into one or more bodies. When this is so, and their orbits are free of each other, they will permanently remain; but even then, if more than one body, should they intersect on or nearly on the same plane, the work will be incomplete. Thus, in the end, the countless planetoids of this chaotic region being formed by their motions into a single body, there would be a ninth primary in the system. This would fill up the only link which is wanting. The primitive condition in which these innumerable asteroids and planetoids now exist, is in a certain sense fairly typical of a corresponding state of things which at a remote time prevailed in the latitudes beyond, and it to a limited degree accounts for the enormous overgrowth of the major planets.

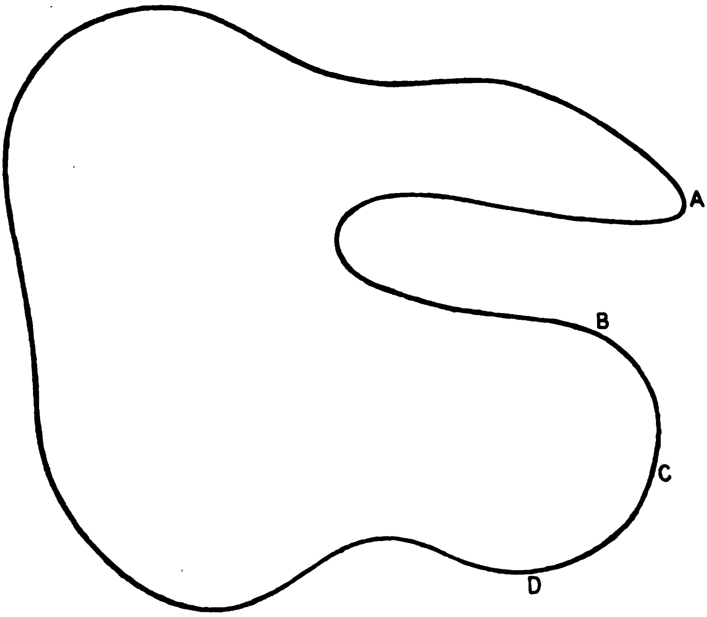
One of the most remarkable circumstances in the grouping together of secondary systems is, that the subjected bodies in all cases, as far as discovery extends, have their days and revolutionary times exactly equal. Each one revolves round its orbit to a second, in the same time that it turns upon its axis. Here, then, we have one incontestable proof that they were reduced to their secondary condition as above described. Had Nature placed them at the first in their present positions, as the planets of the sun, there would have been no such coincidence. By some unknown law, when these small bodies were caught within the attracting spheres of the planets destined to rule them, it appears that their previous planetary motions which they received from the sun may have been indirectly continued. How long, is a mystery. It may have affected them until they were led into proximity to the planet, round which—in obedience to its rotation and at the right distance—they revolve in the exact times they severally turn on their axis. This is a marvel of science full of wonder; thus far beyond human conception to account for. It is, however, an established fact, and applies to all the satellites whose rotations are known. No doubt, judging from such discoveries, it is common to all lunar bodies; and, as will be seen hereafter, it is one of the allwise but unknown laws bestowed by the Almighty as indispensable for the welfare of His creation.

To give but the slightest idea of the fatal tendency of all bodies to incorporation with the planets, when once within the charmed spheres of secondary rule, it is incumbent upon us to elucidate in a somewhat truer light the formation of secondary systems. The principle in itself is not much studied, yet it is indispensable if we wish to have a clearer knowledge of creative design. Hereafter we shall have to enter more fully upon the subject, so that our remarks must be of the most perfunctory character.

A careful study of this subject enables us to demonstrate that atoms and particles up to aerolites make up a great part, and, in one sense, the whole of the matter which compose the worlds. Revolving motion is common to all, from the atom upwards, and all being made liable in their whirling course round space to fall upon and unite, these primal steps in the bringing of new matter together are in no respect indebted to attraction, except indirectly. In short, newly-generated atoms, the same as worlds, the instant they come into being, subject to the rotation of the sun, revolve and at the same time gravitate. Their uniform direction is, as in the case of all revolving motion under our sun, from west to east, while their two motions—revolution and gravitation—cause them primarily to come upon each other as atoms that increase by combination into particles, while the latter in turn combine and increase into aeorlites, and the aeorlites also by recombining are, in rare cases, enlarged into planetoids. When once the collection accumulates into the dignity of a planetoid, being an attractive centre, its sunward gravitation ceases, and it is for a length of time an independent body, the same as a planet.

Such is a description of the system as it actually exists. Unseen planetoids innumerable are constantly being created and as often incorporated, but the operations are now only on a small scale, for where there is at present one planetoid, when planetary formation began there were thousands. They in their then numerous state revolved, and as their orbits from their varied eccentricity naturally intersected at millions of crossing points by the same operations which combined atoms, particles, and aerolites into planetoids, they overtook each other and became mutually incorporated. Thus, step by step, they rose in magnitude to asteroids; of these last, odd ones—perhaps one in ten thousand—from the selfsame operations took the lead and became higher secondary centres, and afterwards our primary planets. These latter, in the course of time, by the power of their attractive spheres, swept all others which by their revolving motions invaded their tracts into themselves, leaving but a very few asteroids exceptionally large, and which were saved from the common fate of the others, in secondary subjection as moons by virtue of their slower rotatory motions.

Such, briefly, is how the bodies of the system first originated, facts which our subject forces us prematurely to notice, that a vague idea may be formed as to the true conditions under which secondary systems primarily sprung up. When, for example, a very large asteroid was, by its revolving motion, caught within the attractive sphere of some one of the great planets—if its rotation happened to be the quickest of the two—nothing could save it from its fate. The instant it gets by its orbital motion entrapped within the meshes of planetary sway, it becomes subjected to that unknown law which leads satellites, when first laid hold of, to approach their primaries to that exact distance—not a hairbreadth more or less—wherein its revolution, under the rotation of the planet, is performed just in the time it turns once upon its axis. In order that this may be possible, the newly-caught asteroid must rotate slower than the primary, otherwise it must necessarily succumb to its fate. It then follows, that at the beginning all bodies, no matter what may have been their magnitude, which happened to be gifted with quicker rotation than the planets under which they were being caught, became one and all incorporated with them; while, on the other hand, a very few of those having slower rotation were preserved in a secondary state as satellites. To have any chance of being saved, their rotations had to be considerably slower, and it was indispensable that they would be of a certain size, neither too large nor too small, in relation to the planets. If, for instance, an odd one—for when primal matter was first working itself from the atomic state into worlds, they naturally, among the innumerable hosts of small bodies, assumed all degrees of size—was found too large to be governed,—between ruling and subject bodies, there must always be a wide difference in magnitude,—no matter what its axial motion was, if it did not escape through a too near equality of size, a collision was inevitable. Where both were enormously large, the formation of a ring might be the result, but if too small, such as a planetoid or small asteroid, it would lose its centre of gravity by the stronger attractive force of the greater body acting upon it, and thus, as it were, fall like a huge aerolite into it. Such phenomena, however, which must have been repeated millions of times to build up the major planets, had not the least effect in disturbing their equilibria, because the forces that produced the collisions proceeded from the larger bodies collided upon. Among the innumerable objects, however, including aerolites, planetoids, and some asteroids, which were constantly by their orbital motions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stumbling into the power of the larger planets, a very few in the course of time, before being laid hold of, happened to have become by increase of matter as minor centres so enlarged that when their motions led them within the grasp of their future rulers, and to the right distance at which their diurnal and revolutionary motions would be performed in the same exact time—the one thing indispensable to a lunar body—the huge planets at this their nearest possible point of approach had not sufficient attractive force to impose gravitation upon them. These are the only bodies in the system which, by virtue of their slower rotatory rates, became satellites. As a class of bodies, they have all been brought under secondary subjection and not destroyed by collision, on the before-mentioned principles—namely, that they had attained a requisite magnitude, and were slower in their axial motions than the planets which were destined to seize and henceforth govern them. It is a merciful prevision that such is the case, especially when we consider what would have followed if all bodies, large enough to be attractive centres, the instant they were caught, had as satellites commenced to move round them. Under such a condition of things, nearly all the matter now forming the planets would have remained, from the smallest planetoids to asteroids, near the outside of their attractive spheres, and that at the distance where they were first caught. Here they would have continued permanently, useless as habitations for the living.

CHAPTER VI.

FORMATION OF RINGS.

For reasons which in their proper place will be submitted, we define the rings of Saturn to be composed of the same kind of materials as the earth and all the other bodies of the system, the sun included. The preliminary task is, therefore, imposed upon us to say something as to how such singularly-shaped bodies are supported, or rather what saves them from collapsing and falling to pieces.

The supposed weakness of annular bodies has long occupied scientific minds, and that under the popular fallacy that for bodies to be safe they must be round, or at least that they should not deviate so widely from the globular shape as do the rings of Saturn. From the workings of the natural operations which have gradually built up the heavenly bodies, it is impossible that they could have assumed any other than globular shapes, but these are not necessary in the remotest degree for the purpose of their safety or holding the parts together. Nature imposed roundness upon them from their earliest formation, and if the matter of which each is composed had been made to assume any other arbitrary shape or shapes, the strange outlines of their figures would have been, so long as the outlying projections were sufficiently large in relation to all the rest, as immutable and eternal as if in the globular form.

To illustrate the principle, let us suppose that Jupiter, or any other planet, had had its materials drawn into a body of the following fantastic, but, as the operations of nature work, impossible form. The first idea that would occur is, that such a body would, by the ponderosity of its enormous limbs, fall to pieces; but that is impossible so long as the attraction of each part is the strongest on its own materials. If Jupiter had assumed such a shape, he would have been as safe, sound, and perfect as with the rhomboid form given him.

Take, in the first place, the point of the horn at A, and see if it would be possible for the materials composing it to fall in the direction of B. The mass of matter at and above A possesses in itself a stronger attractive force than any attraction that can reach it from the much larger wing of the body B C D. Hence the aggregate of the particles which make it up cling upwards and cohere together, instead of dropping to pieces in the direction of B—the strongest attraction from without acting upon it. The wing B C D being in comparison much the largest quantity of matter, must of course in itself have a stronger attraction, but as this force always decreases according to distance, A being several thousand miles from B, the attraction of the latter, although stronger in itself, must become much weaker than the same force at the surface of the horn A. The whole point is thus perfectly safe not only from the attraction at B, but from the same force reaching it from any other portion or wing of the body, all its materials cling up together and keep solid simply because its own inherent power acts upon the whole with the greatest strength as opposed to all others. Thus, if such a formation in nature were possible, the outlying limbs of the above fanciful three-winged body would be as safe in all its parts, retaining them unchanged for ever, as if they were collected into a globe. Let us add, that the horn A would still be in unimperilled safety if a mighty convulsion of nature were to rend it to the centre, for the parts, although disjointed, would possess the same attraction as before, and collapse into much the same shape. If we were to reason *seriatim* over every separate member of this strange and grotesque body, we should in like manner find all the parts of the structure equally safe, and by nature capable of retaining the same features to eternity.

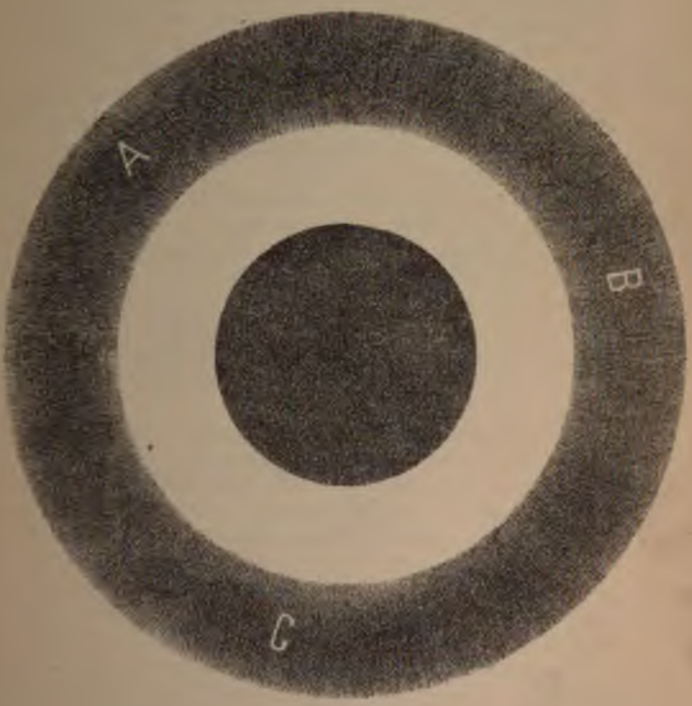
The reasons thus advanced for the perfect support and safety of irregularly-shaped bodies—if it were possible that natural operations could produce such monstrosities—should remove the difficulty of the rings being unable to support themselves, but as it is a question which has puzzled many, we may refer to the figure before us in further elucidation of the principle.

While we unhesitatingly hold that the ring A B C itself is, just the same as the earth, composed of granite, water, or aqueous rocks, and other kindred materials, yet we prefer, for the sake of adding strength to the reasoning, to take an extreme view of the case and imagine it to be wholly composed of water—the most unstable of all materials. Even if it were so made up, it would as a body be as safe and sound as though it were a mighty ring of metal, without crack or flaw, or like all known planetary bodies of a globular shape.

It is a common saying that water will find its level, but all men who traverse the ocean well know that instead of being level it is globular; and it is made to assume this form by reason of all its particles naturally running in the direction in which they are attracted. The ring is supported, or, we should rather say, retains its shape on precisely the same principles, no matter what may be its materials, with as much solidity and permanency as if the whole were compressed into a globe. Take, for example the waters of the ring at any particular point, A for instance. Now, the bottomless ocean of waters at A will flow or fall in the direction to which they are most strongly attracted. The ring, we should state, is acted upon by two attractive forces—the planet on the one side, and the total thickness of the ring, self-acting upon its own materials, on the other. The attraction of the planet is by far the strongest of the two forces *per se*, but according to distance it becomes weaker, and therefore reaches the ring in a much more enfeebled state; while the attraction of its mass of matter at any one point round its entire circuit is stronger than the attraction of the planet, or indeed of any other body which can reach it, otherwise as a material structure it would at once crumble to pieces, its broken fragments descending upon the body having the strongest hold upon them. The waters composing it, therefore,—on precisely the same principles as those on the surface of the earth, are globular,—flow towards the centre of the ring, not on one but on all its parts. Thus as a body, although we have assumed it to be of liquid materials, it is kept throughout as compact, safe, and unchangeable as the planet that governs it.

Another difficulty, which in reality means the same thing, presents itself to reflective minds—namely, How is it possible that the ring is preserved from collapsing, considering the inconceivable weight of its parts pressing, as it were, laterally upon each other? Perhaps there is no more beautiful example to be found, in proof of a total absence of weight in any of the heavenly bodies, than the rings of Saturn. If they, taken as wholes—not the clods or stones on their surfaces—had any ponderosity, they would crash to pieces in an instant; but we will let that pass. It has been supposed by a few that, the whole structure being circular, it was kept together on the principle of the arch. The arch gains strength by the collapsing weight of its materials. In like manner it was argued that the great annular body had only strength and firmness added to its materials by common pressure down equally toward the circular arch common to the whole structure within. Such an idea, after being dealt with seriously, was ultimately exploded, and the formation and support of the ring were accounted for in quite a different manner. It was then learnedly propounded that these bodies, or rather appearances, were made up of innumerable satellites, so closely studded together that at such a distance they present to us an unbroken surface. This certainly has the merit of being a novel mode of solving a difficult question. Unfortunately, the theory was left incomplete by not explaining how so many small bodies were brought together so as to form annular figures.

That the different sections of the ring do not laterally crush each other is very easily explained. Taken as a whole, the ring is of no more weight than the same measurement of space it fills up, and this is equally applicable to its several parts, if marked out in short divisions for the purpose and separately considered. No doubt, if we were on its surface, we should feel more or less heavy; the objects around us would likewise be heavy in an equal degree, and that according to the attractive force of the ring as a body, drawing towards its circular centre the matter on its surface. We should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also find that we, as well as the multitudinous objects around us, gravitated not in different directions, but to one single point in the ring. In like manner it could be demonstrated that in all portions of the ring the particles of matter or objects, wherever they might be, must gravitate to the same circular attractive centre and to that point nearest to them. What is common to all the parts must be common to the whole, and, consequently, every section of the ring in harmony with all the particles which compose it—although the ring is joined throughout as an unbroken whole—is as independent of all the others as if it, as part of the body, were detached from it. No one part can laterally press upon another; hence the annular body continues permanently safe without changing any of its features.

The operations that have gathered together the secondary systems are the same as those which led to the formation of annular bodies, wherever they may be. Such formations are probably to a limited extent more or less common to the whole universe, but only within the precincts of large suns. In explaining the formation of secondary systems, in order to simplify the subject, we had to adopt the false principle that the worlds, during the operations, had already attained their present maturity in magnitude; but to trace out what led to annular formation we cannot reason on rules so simple, and must of necessity shortly examine, even at the risk of being in this chapter unintelligible, creation in a more primal state.

We might conceive of a time in the remote past when, throughout what may be termed the regions of Jupiter and Saturn, there were instead of two large planets, attended with a few moons and rings, a broad expanse covered with millions of planetoids and asteroids, all spread as the lowest class of independent bodies over the broad expanse. The sun, even then, was a mighty orb; but, as it was the early dawn of the formation of the worlds, he was by comparison little. Round him the innumerable millions of planetoids referred to, as soon as they existed, rolled on their respective orbits, at their various distances, and—what must be specially kept in mind—for the most part lying, as all planetary bodies now do, nearly on the same plane, being inclined thither in obedience to his rotation. Thus related to each other, all on orbits differing in eccentricity, their motions gradually led one to overtake and fall upon another—not to meet at the intersecting points, for they all had more or less of a uniform direction from west to east—until in time a number of asteroids were formed. As these larger bodies increased in size by the same operations, they formed greater centres into which the others, one by one, became incorporated, until at last one or more increased to the dimensions of large planets. These abnormally large bodies, in a degree equal to their magnitude, became eventually great centres, and by their movements collected into themselves the asteroids, planetoids, aerolites, particles, and atoms of matter existing within their rule or that touched by their movements their tracks round the sun-

Their ranges of rule, so far as collecting into themselves these formations is concerned, included the circular belts of space, each nearly concentric to the other, which their expanded attractive spheres passed over in revolving round the sun. Every planetoid or asteroid went round the sun in like manner, as they still do, from west to east, and whenever their orbits touched any of these belts of space, it was their fate to be incorporated by their revolving motions into whichever of the great planets their movements interfered with.

It so happened that throughout the circular region swept by the attractive sphere of Jupiter—one of the two newly-formed great planets—that no other body grew up to such great proportions as to take a commanding lead; and consequently all the small bodies, mostly little planetoids, which came within the sweep of his attraction by their orbital motions were, in a length of time reaching back from the present to the period when centres of attraction through the first origin of motion commenced, became incorporated into him, except only four among the largest, which, by virtue of their slower axial motions, were attached as moons. This planet practically absorbed all created matter within its range—a process natural and inevitable, considering the then scattered chaotic state of creation. In the much larger region traversed by the attractive sphere of Saturn, and within which creative operations left about an equal proportion of matter, instead of one, four bodies took a leading part in absorbing the innumerable smaller collections of matter. There were thus four great centres, instead of one, as in the region of Jupiter; but three of these by no means equal in magnitude to Saturn himself. From the first he must have been much the largest—the planet whose materials formed the inner ring, next in size; the middle ring representing the third; while the fourth and last, which made up the exterior ring, was the smallest of all. Even this last, small as it was, must have been itself a large planet, otherwise it would have been beneath the standard to form out of its spread-out materials an annular body so widely extended, however thin it may be.

The four large planets in question would have for ever remained independent of each other, had their orbits, as is the case with all the primary planets now in the system, been free from the fatality of intersection; but as related with the parent body, and most likely one with the other, there being no very wide differences between them in their respective distances from the sun and their orbits, like those of all other bodies varying in figure, and the other and far more important quantity in the consideration—the solar position in relation to each—all these circumstances upon comparison prove that their annual paths had to intersect, not only in common, but that the orbit of Saturn, if not intersected, must have been approached sufficiently near for their being in due time laid hold of. It is quite possible that very small bodies may intersect the orbits of large ones without while in this early undeveloped state ever coming together, for, as a general rule, they lean very considerably out of the common planetary plane, and this for immense periods of time may save them from being incorporated; but to full-grown planets, their shapes having reached perfection of mould, such as we are dealing with, the rule does not apply. The primary planets actually in the system we may assume to be bodies all matured into perfect shape; as a consequence, they lie so nearly on a common plane that, if their orbits intersected, they could not escape each other. It must have been the same with Saturn and the three other kindred planets revolving near his latitude. We may therefore conclude that these four great planets, which were in time to form so intimate a relationship, had their orbits inclined from each other in no greater degree than such figures in connection with the primaries are at present; and this being granted, it follows that as their movements were round a space traversed eccentrically by the mighty planet, surrounded with his attractive sphere of from one to two hundred million miles in diameter, their fate was sealed whenever their revolving motions led them in succession to touch upon the wide precincts of his rule.

No rings could have been formed except from large planets, springing into existence so near the same latitude that if their orbits did not cross, at least through their eccentricity they touched at some points round which the attractive sphere of the great planet swept. As a consequence, creation remained still imperfectly organised in this wide belt of the system—so far as relates to the earliest formed secondary bodies—traversed by the attractive sphere of Saturn, while one of the four planets trespassed either upon the tracks of each other, or in common upon that of the planet. The natural result in the end was, that Saturn caught within his embraces—and the word "embraces" means the expansion of his attractive sphere—the three others, the necessary degree smaller; the collisions, occurring at times widely apart, being brought about, as is universal in all cases, by the revolving motions leading the smaller within the attractive sphere of the largest, and that when the bodies were in conjunction with the sun, at the right position of the circuit and in sufficiently near proximity. No other effects could follow two or more bodies in any portion of space—if they at any point trespass upon each other their inevitable end must be coming together at some future time, earlier or later. It is on the same principles that planetary bodies have been made up, and secondary systems, with all their peculiarities, formed. Whenever they intersect or at any point invade the tracks of each other's attractive spheres, the smaller become incorporated with the larger, excepting in the rare instances when they are reduced to satellites, or when, less frequently, they have their materials expanded into rings. The latter formations entirely depend on the colliding bodies being large, but very inferior in magnitude to the bodies collided upon. All the small collections of matter from planetoids, the lowest class of independent bodies, upwards, were absorbed by the primaries in the past, and, on a smaller scale, are continuing to be so, except in the case of the largest asteroids, odd ones of which, if so constituted, may be preserved as moons. In regard to Saturn, three other great worlds being contemporary, and so near the same latitude as at points to touch upon the track of his sphere of attraction, it was their fate at their appointed times to collide, and all the indispensable conditions meeting with each separate collision, the formation of rings took place, the latter being nearly, if not wholly, made up by the spread-out fragments of the smaller.

When two great bodies collide through their revolving motions, the force of the collision depends on their difference of magnitude—the wider the difference, the greater the force. Thus, if the revolving motion of two planets, equal or nearly equal in size, were to lead them direct on one another—their attractive spheres being of about the same expanse—there would be no force in the collision. As bodies being by nature without weight they would have no motive forces, and weight neither could possess until it was imposed upon them by the attraction of the one upon the other, a thing impossible by two equal attractive forces acting in opposition. Being of equal magnitude, no matter how near, the one body could not impose gravity upon the other. Even when they touched, the whole materials of each would still cling to their respective centres, and thus both, notwithstanding the collision, would each continue whole and sound, there being no inherent force in one to rend and destroy the other. Like shadows, they would simply come upon each other with not a grain of attendant force. The collision would leave no ring behind it, and the only disastrous effects produced would be that the one body would shoulder aside the other no farther than the breadth of itself. They would stumble safe and sound apart, and continue on orbits with the same regularity as before.* In the next place, if we describe the collision of two bodies differing not very widely in size—about one-half difference might meet the conditions—gravity would only be imposed adjacent to the point of contact, at the instant of collision, on the outside portion of the smaller. The concussion would be slight, and of such a nature that the smaller would not escape incorporation. The mighty catastrophe would be the work of minutes. Only the surface adjacent would have gravity to the larger, and in a perfectly loose state it would flit in flakes from one body to the other, as large as mountains. Thus the incorporating force would be enabled to quickly sink deeper into the vitals of the doomed world till it became part of the larger, and that with the smallest degree of colliding force with which any two bodies of the same size could be mutually incorporated.

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* No bodies can ever collide that are of equal or nearly equal magnitude, except their motions bring them right on to each other. There are so many chances against such occurrences that, while they are not impossible, it may be said that they never happen.

From the foregoing imagined examples, it must be evident that through the absence of sufficient force no rings could be the effects of such collisions. Any collision which could form a ring must take place between two very large bodies—one much larger than the other—to enable it by its stronger attraction to impose gravity, or rather falling motion, on not only the side adjacent, but, immediately before the collision, on the total mass of the smaller. Let us take one of the three bodies which had their orbital relations with Saturn as already described.

Both planets, Saturn and the one out of which, we will suppose, the ring is about to be formed, moved round their orbits from west to east, and they most likely came into conjunction with their ruling body, the sun, many hundred times previously, but except a conjunction took place at one of the points where their orbits touched in common—we are here speaking not of lines invisible from their smallness, but of those as thick as their attractive spheres were wide, or being, like the existing planets, nearly on the same plane—no collision was possible. However, from the nature of their relations, the crisis was inevitable at one time or other, and at last, possibly after the lapse of millions of years, the two came into conjunction with the sun sufficiently near one of the fatal points, and the collision took place, the principal effect produced being the formation of one of the rings.

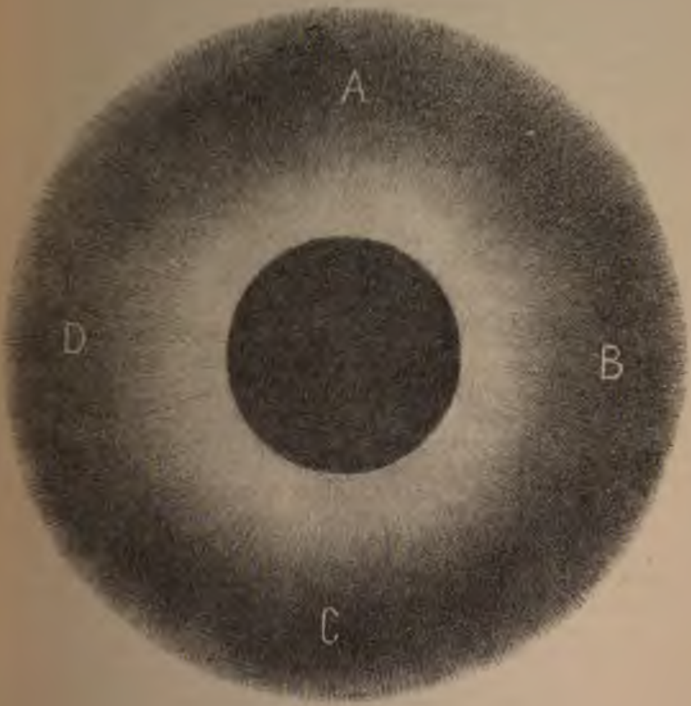
The instant prior to the collision, the smaller of the two began, by the overpowering attraction of Saturn acting upon it, to gravitate. In other words, the attraction of the other planet reached the smaller with a stronger force than that inherent in itself, at which instant it parts with its centre of gravity. The change was momentous; scientifically speaking, life is gone out of it! Heretofore, as a large world, its materials were hard, compact, and firm together, in obedience to the attraction from their native body, drawing them in common to its centre. Now, from the near proximity of the destroyer, they are more strongly acted upon by an exterior force, and fly to it as their new centre. The bond which during the long past held them all together is snapped asunder, and the body throughout, from centre to circumference, is instantaneously loosened and disjointed in all its parts, and in this state of dissolution it rapidly collides upon the planet. Previous to coming in contact, and while at a safe distance, the doomed planet had no force in its motion. In itself, taken in the whole, it was neither more nor less than the weight of a shadow; but the instant its fatal heaviness began, that is, when it was so near as to become buried in the stronger attraction of Saturn, all its loose parts becoming proportionately heavy were instantly endowed with the force of cannon balls, millions of millions of times multiplied, and the large particles, loose stones, and disjointed rocks of a world, dissolved previous to contact, dashed over the body of the great planet, shaking it to its centre. The materials of the smaller one, instead of, as is usual in ordinary collisions, becoming incorporated with the planet, spread out by the force of their weight—not the weight they previously had from their own native body, but the new weight imposed upon them by the destroyer—into a circular wave which immediately by its shooting force scattered far and wide into a circular ocean. From the nature of the grand operation, the bulk of the coarser fragments were ejected to the outer portion of the circle and where the projecting force became expended, the intervening space between them and the planet probably being a continued but much thinner sea of finer material.

Such was the chaos produced by the collision. Saturn, no doubt, was shook to its centre by the smaller colliding planet coming upon it with meteoric velocity, and that not as a solid body, but as a globe of incoherent sand—the term sand we are justified in using, for the disjointed rocks and stones of the disintegrated world, in comparison to the total bulk, would be no larger than grains of dust—dashed out in the circular form we have described, into an ocean of mist. As the materials in their loose state had collectively the same force of attraction as if solidified, out of this spread-out ocean of matter the ring very soon consolidated into the perfected annular body which it now is.

In the centre of the shot-out materials, round the circle A B C D, a common centre of attraction at once existed, into which all outside quickly collapsed, and all inside flowed either to the ring or the planet, according as the particles were acted upon by either body. Undoubtedly the bulk of the matter in the interior space between the ring and the planet must have fallen to the latter, as being in itself by far the strongest attractive force; but it is evident that at the nearest distance at which the materials are consolidated into the ring, the attraction of Saturn was and is weaker than the aggregate of the loose matter thus falling in and consolidating together. Hence the ring soon became a solid appendage round the planet, having, whether loose or consolidated, a stronger attraction than that which reached it from the latter.

To describe the collisions which formed the other ring, or perhaps two rings, would only be to repeat what we have said. Annular bodies, wherever they may be, have been formed on the same identical principles; but that each one of Saturn's rings in succession should become more expanded than the other, the collision in every separate case had to be with greater force, and the colliding planet to produce the required force in the same degree smaller, yet of large magnitude, as if too small no ring for want of sufficient material could have been formed under any conditions.

The conclusion that a smaller colliding body would collide with a greater degree of force than a larger may appear absurd, but keeping in remembrance that we are reasoning on bodies, the smallest of which was perhaps nearly as large as the earth, we may, in the first place, observe that the distance when gravitation is first imposed upon it must greatly affect the degree of the colliding force. Suppose, for example, that there were two bodies



FORMATION OF SATURN'S RING.

R. Paterson, Lith.

[illegible]
[illegible] NS.

about to collide upon Saturn, one the size of the earth, and the other twice as large. The latter could only have its own attraction overcome and begin to gravitate when very near, say ten thousand miles, while the former, only half the size, would begin its fatal headlong descent at least ten, or perhaps a hundred times the distance. Each body would increase in weight the nearer it came at much the same rate, but as the smaller body would descend ten times the distance previous to contact, it would according to its bulk strike with vastly greater force. The materials of both bodies once on the surface would be exactly of the same weight, but the difference would be in the force of the approach of the body which had gravity imposed upon it at the greatest distance.

To take another view of the question. A body about to collide has no motive force, whatever the velocity of its motion may be, or as it is termed momentum of motion, till it gets so near the larger as to begin to gravitate to it. If the gravitation is imposed upon it a single instant previous to the contact, having the full benefit of its rapid orbital motion, it strikes as a body of disintegrated loose materials with the same force as if the weight belonged to it all along. In this respect, a larger and smaller body are on equal terms, but it is the weight imposed by the planet upon each one of the bodies respectively that causes the difference in their colliding forces. The weight we are speaking of, it should be borne in mind, in no respect belongs to themselves, but wholly comes from the planet, and is to be measured by the force of its attraction upon them separately. The largest of the two having within it a stronger protective force according to its greater quantity of matter, it to the same measure neutralises the opposing attraction of the planet. It therefore collides, although with awful force, yet much more sluggishly than the smaller. In short, under the circumstances, if both were put in the balance, just previous to contact and at the same distance, the smaller would be found heavier in proportion to its lower magnitude.

Long ages are likely to have intervened between the formation of the respective rings, but whether the inner, the middle, or the outer ring—if there is a third ring—took the precedence, it is impossible to say, nor does it in the least degree affect the merits of the question. In order, however, to deal with their formation consecutively, we may take for granted that the interior ring was the first formed, and, of course, was made up of the driven-out materials of the largest of the three colliding bodies; the middle ring out of the next largest; and the exterior one out of the smallest. The three rings, as they succeed each other, establish these facts in every particular. The interior ring is of the greatest magnitude, but it is the least expanded; the middle one is of wider expanse, but as to bulk of matter is in the same degree smaller, while the exterior ring is the widest and smallest of all. The latter is attenuated into such that we may look upon it as an impossibility that any other ring outside of it, which would have to borrow the materials of a still smaller body, and would necessarily be more slender, could have been formed. It is not irrational to infer, that other smaller bodies may have collided upon Saturn in like manner, and that they have had their materials spread still wider, but that in so thin a state as to gravitate back to the planet, being in quantity insufficient to have a circular common centre of gravity, so as to settle together into a fourth ring. Indeed we may reasonably conclude that no additional ring could have been formed, however many collisions during the lapse of time may have taken place. From planetoids upwards possibly of such collisions there may have been millions, but it appears that of all the bodies, colliding on the planet during its history, there were only three naturally constituted by their colliding forces to spread out their materials into rings, nearly all the rest having been incorporated with it. This great body, as well as two others of the major planets, has during the course of time been made up principally by planetoids, and in a small part by aerolites. But planetoids in going round their solar orbits—which during their fleeting existence they must do with the same undisturbed regularity as the largest planets—were and always are liable to fall upon each other at their intersecting points, and be mutually incorporated. This causes them in rare instances to be very much enlarged. Hence small asteroids, reaching up to the size of lunar bodies, must have been amongst the multitudinous number which helped to enlarge the great planet: but our remarks upon the incorporation of such bodies—as large as moons—are only applicable to the past. To a certain extent this is clearly established by the fact that only seven moons are attached. Bodies of this size, if of slower rotation, were pretty sure to be satellised, and reasoning upon averages, together with the fact that, with but one exception, the axial motion of Saturn is the quickest yet discovered,* we may rationally conclude that the number of the same class of bodies which approached the planet with quicker rotation, and therefore doomed to fall into it, was not exceeded.

Something more must be said on the condition immediate to contact of a large body, such as our earth, colliding on another the magnitude of Saturn, and the force spreading out its materials so as to consolidate into a ring. The common idea of two worlds thus colliding is that they both meet as cannon balls, striking each other in their full force of motion. On this assumption it may therefore be said that large bodies, such as were of sufficient magnitude to form the rings of Saturn, if they had collided as described, the mighty force of the impacts even from bodies not a hundredth part of the size of the great planet,—we think this is not very far from what may have been their relative magnitudes,—instead of forming rings, would in every instance have shattered both bodies into an ocean of dust. Nothing else would have been the result if it was possible that any of the heavenly bodies could collide as solid bodies, and with the inconceivable force generally supposed as an attendant upon such an event. Returning, however, to first principles, it would be a simple task to demonstrate that no forces, by the operation of two worlds incorporating by their motions, are put in action that could break up or disfigure the largest of them. As previously observed, if the colliding bodies were of equal magnitude in their collision, there would be no force whatever, and they would thus stumble past each other, free from harm. If they differed sufficiently in magnitude then the smaller, if not spread out into a ring—a formation that could only be produced by the collision of very large sized bodies—would simply become part of the larger, and that without the latter being split up, disfigured, or even in any material degree, except for the better, altered in shape.

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* There are at least sixteen lunar bodies in the system, and as their orbital motions tell us to a second the time each one turns upon its axis, we have thus the clearest proof that the quickest axial motion belonging to any of them is slower than the same motions belonging to either Jupiter or Saturn. As regards the rotation of the exterior satellite of the latter, it only turns once in 79 days, or nearly a quarter of a year of our time. If we turn again to other bodies there are only six, including the sun, on which this motion is discovered, and in every case, with the exception of Jupiter, the motion is slower than that of Saturn.

The reason why the smaller colliding body cannot strike the larger with annihilating force is that it descends upon it with all its materials loose and disconnected, and without any natural bond to hold them together. In fact, when a collision takes place, if their respective magnitudes sufficiently differ, the attraction of the larger, the instant prior to contact, reaches all the parts of the smaller with stronger force than that inherent in itself. Thus acted upon, it ceases to be a centre of gravity, and in all its parts falls loose and disconnected on the greater body drawing it in. There is no other principle in the range of science so important as such operations. It intimately links itself to everything connected with the creation and government of the heavens. By and through it secondary bodies have been built up, and are still continuing to be enlarged. Its workings on the lowest scale are being constantly exemplified before our eyes, by aeorlites adding their mites of bulk to our earth; and even falling objects around us reveal, in a certain sense, the secrets of the universal law. Take that favourite projectile the stone, when thrown up it does not, like the colliding world, become in all its parts disjointed and loose, because of the coherency of its matter, but it falls back, and that because it has no attractive centre of its own, or what may be figuratively termed the life of a world. The earth has thus strength to pull it back again. There is not a particle or atom within it that has any inclination to its own centre, or in any other direction except earthward. As an object it has attraction, but only as to its magnitude, and hence the power of the earth over it. If some enchantment could but give the stone the force of attraction, so that its atoms would cling towards its own centre, the power of the earth in drawing it in would be at an end. The attraction within the stone would be stronger than that of the earth reaching it, and in the hand it would thus as a body be so light, whatever might be its size, that the gentlest breath would send it flying away as a shadow, and if let go, while under the enchantment it would hang up in the same place, revolving with the earth, demonstrating in itself, although an insignificant object, all the sublime principles governing the universe.

The colliding world which is about to be transformed into a ring, is subjected on a large scale to just the same influence as the falling stone. Yesterday it was a large independent planet, pursuing its undisturbed way round its ancient orbit; to-day its movements have plunged it within the fatal precincts of Saturn's rule. When thus caught it may have been fifty or a hundred million miles from the parent planet itself, the distance depending on what may be the expanse of the planet's attractive sphere; but no matter what the distance, it could never escape out again, for once matter in any condition, whether atoms, aeorlites, or worlds, are within the precincts of secondary rule, they are universally doomed to descend on the ruling body within, except in the very rare instances of bodies of the requisite size and which have considerably slower rotations. The latter our new-caught planet could not have had as it continued to be charmed in, nearing the destroyer by some unknown influence peculiar to secondary rule—not by gravitation, for so far it still retains its attractive centre, but it becomes weaker until at last its heart's life is drawn out of it. Saturn's attraction, as it continues to come into nearer proximity, finally becomes stronger on all its parts than its own, the bond that held them firmly together for ages is snapped; all its materials, instead of clinging to their native body, fly off in the direction of the stronger exterior force, and the mighty mass is as a ball of sand without cohesion. The falling body, although its total materials become at the last moment dislocated, loose, and deprived of all weight except in the direction they are being drawn, yet, in the absence of any forces to spread them abroad, it still comes in contact as a great globe, being disjointed and loosened instantaneously in all its parts. Coming into final contact the materials spread out with fearful impetuosity, not sufficient to split up and destroy the great planet collided upon; but with a force proportionate to the weight of the fallen materials on the surface of so large a body, and their velocity of approach. Both these causes sent them out rebounding from the planet into a circular ocean, out to an equal distance, by an equal impelling force, and the bulk reaching towards the outer circumference of the vast ocean space of projected flying matter, all by the inherent attraction in the whole collectively, soon collapsed together into a flat annular body, termed a ring.

We may have a still clearer conception of the mighty operations of annular formation [illegible] subject by supposing that the earth [illegible] times larger [illegible] tersected [illegible] some point of the [illegible] larger passed [illegible] The earth being [illegible] be eventually [illegible] sufficiently strong [illegible] sufficiently [illegible] to form a ring. When [illegible] attractive sphere of the larger [illegible] slower rotation [illegible] as the earth, it is likely, would be reduced to [illegible]. When caught within the first grasp of secondary attraction [illegible] would descend with [illegible]—not by the [illegible] attraction from the destroying body, but by an [illegible] which quickly leads bodies [illegible] to destruction. However, in its rapid descent to the planet, when coming near it, all its parts instead of clinging as heretofore to its own centre, like the falling stone, would have their new centre in the great planet, and thus, the instant before the collision, they would become disintegrated, descending in this loose state and the whole spreading out with an immense force on and to a distance from the planet. The measure of the force would entirely depend on the weight imposed on the falling materials at the surface and their velocity of approach. Our earth, previous to the time of losing its centre of gravity, could have had no motive force, as it was then and before a body like a shadow without weight; but the instant its near approach gives the attraction of the greater planet the mastery over all its parts, then weight in the same degree is imposed on the whole; but not as a solid body. The instant the terrestrial materials would have weight imposed upon them by the stronger attraction of the greater body, the earth would be a mighty mass of looseness, without any coherence. In this state its disjointed parts would descend, by their velocity of motion, with exactly the same degree of force as if the same weight had from the first belonged to them.* The motive force, however, thus bestowed upon them at the last moment would not be on a solid body, but on a mighty mass of looseness; yet even in this state the collision would be tremendous, far above what we can describe or experience! For we are to consider the rapid approach of the previously dislocated fragments of our planet—as large as the blocks of stone which compose our mountains—striking with a weight as much heavier as the attraction of the huge body they are falling upon is stronger.

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* It will be seen that in substance this passage is a repetition of what we previously advanced on annular formation. It will be one of the features of the work throughout, that leading ideas we look upon as important will, time after time, be repeated whenever we think they will add strength to any subject we are reasoning upon.

The weight of material must, therefore, be in all situations according to the force of attraction acting upon it. Thus on the surface of Saturn, a body a thousand times larger than the earth, and with attraction proportionately stronger, the lightest pinewood, bulk for bulk, would be heavier than gold; and as the degree of projective power depended upon the weight of the materials, we at once discover the true cause of the force that spread out the materials of the three different ruined worlds wide enough to consolidate into rings. All their fragments, when reaching the surface of the great planet, would become at least twenty-fold the weight of terrestrial matter, and consequently by their collision they had that much greater force applied through the agency of their previous velocity of approach in being projected out wide enough to be rings.

The great weight of the collided materials of large planets on the surface of Saturn, together with their rapidity of approach, viewed rightly, sets at rest the question of force as requisite for the sufficient spreading out of the materials into rings, and at the same time meets another question, why no annular formations resulted from similar collisions in connection with smaller bodies. Just as the strength of attraction of the bodies collided upon, so is the weight of the fallen materials: and as the projecting force entirely depends upon the weight, it follows that no collisions could produce rings except upon bodies ranking in magnitude with the major planets. If smaller, the colliding materials would be in the same degree lighter, and would lack the requisite force to shoot them out sufficiently wide. Our earth and moon for instance, two bodies we suppose which in comparative magnitude meet the conditions of annular formation, at one time were brought together under precisely the same circumstances as led Saturn and the planets together, out of which the rings were formed. There was just this difference, that they, through the quickness of their rotatory motions, were led to destruction, while slower rotation saved our moon from sharing a worse fate than secondary subjection. If she had been gifted with a quicker rotation than that of the earth, collision would have been inevitable, but without the requisite force, because the lunar materials through their incorporation would only have had terrestrial weight imposed upon them, and that is far too light to give projecting force for the formation of a ring. In short, the formation of rings may be looked upon as impossible, except by bodies not much smaller than the earth colliding on others many times larger. In the former there are sufficient materials for the rings, and in the latter there is a force of attraction that imparts the same degree of weight, which is just that much added force to the materials that would propel them out as a circular ocean, the outside of which, having an attraction in common stronger in itself than that reaching it from the planet, would necessarily consolidate into a ring.

The shock, as we have said, which Saturn must have sustained by the crash of the loose materials that formed any one of the rings—a disintegrated world pouring on its loosened matter in bulk, reaching the surface with aerolitic speed—the disjointed rocks ground into powder no doubt shook it to its centre, but it was powerless to break it up, for the same attraction that imposed such excessive weight on the flying materials gave to the body itself a compressed solidity to withstand the collision. In short, it was a loose body deprived of the common bond of connection previously holding its parts together, emptying itself over the adjacent surface of a huge planet, solid throughout, and as much more solid, compared to the earth, as its attraction is stronger, and perhaps a hundred times larger than the total materials of the great world that with such rapid velocity are lighting upon it.

These facts must be self-evident, if we only take a broad view of the two worlds in their relations to each other—the one a mighty globe, most likely of greater magnitude than the earth at present, and the other vastly larger. Their respective positions were so near the same latitude that their orbits, if they did not intersect, at least approached at some point near each other. Very likely the two kept apart for millions of years, but at last, what was inevitable at one time or other, their orbital motions so led them that the smaller stumbled within the grasp of the larger, when of course its fate was sealed. Hitherto it was the same as the earth, a solid body, and continued such till its fatal approach brought it so near Saturn that his attraction acted stronger on its materials than that inherent in itself as a body. At that instant, therefore, all its parts gravitated simultaneously to the planet instead of what was before their own centre. Thus the great globe, as so much incoherent sand, poured over the adjacent surface of a vastly larger world possessed of a solidity proportionate to its stronger attraction. Under such conditions the greater body with its wonderful compact solidity could not be smashed up by the loose materials of a world by comparison so insignificant falling upon it. No doubt the grand operation swept Saturn clean bare of his mountains, but as to any other effects the fragments of the fallen world merely rolled for a certain distance with lightning speed over a part of its surface; and through the great weight imposed upon them by the attraction of such a huge body, they were, as repeatedly observed, impelled far out in a circular shape through surrounding space, so wide that the matter had in its misty state within itself collectively a stronger attraction than that of the planet at the same distance. The final result was that the ocean of particles were of necessity obedient to the more powerful material force inherent within, and collapsed into the circular centre of gravity common to the whole, instead of falling back to the planet, and very soon consolidated into a ring.

The materials of any one of the ruined worlds dropping upon the surface of the great planet with lightning speed, and with a weight ten times heavier than gold, as above observed, supplied all the forces necessary for the spread-out, and the bulk of materials requisite for the formation of a ring; but how it was that any force could project them out in a circular ocean so many thousand miles from the planet is yet to be considered, for, according to our experience, no force that the imagination could conceive would have such an effect. The projectiles discharged from our largest guns have their forces expended within a distance of a few miles at most, and on the same principles the rebounding materials, admitting them to have been acted upon with ten times the force; it may be looked upon as impossible that they could have been spread out more than the same proportionate distance. So far true, if all the circumstances in regard to the opposing forces held good, but they are, in all respects, reversed. Beginning, for instance, with the lowest projectile—a common stone. It takes a boy or man his full strength to throw it above a hundred yards, for the simple reason that it has to force its way for the whole distance through air—an ocean of fluid matter—till the applied force becomes exhausted. If, with the same force, the stone was thrown in vacuo, we are afraid to say what might be its velocity, or how far it would go, perhaps hundreds of miles. Again, the cannon ball, when thrown, instead of moving rods goes miles, and that because the projecting force is so much more powerful. Both objects meet with the same opposition in a sea of matter they must forge through, and in which they can only penetrate a comparatively short distance, whatever may be the force applied.

There is one property in the air, however, it gets gradually thinner vertically, and at a certain altitude attenuates to nothing; besides, from its nature in that direction it gives least opposition, according to its density. Now the experiment would be well worth the powder and shot—in testing the 81-ton gun it would cost nothing—for one of our largest guns to be discharged at the true perpendicular, to ascertain whether the ball would ascend quite through the atmosphere. If it would rise the whole distance, and we think there is little doubt that it would, and the force still unexpended, as it would afterwards meet with no opposition, or rather as it would be moving in vacuo, we know not what velocity it might attain—perhaps it would shoot out to annular distance. At all events, a shot sent up perpendicularly, as described, if unable to pierce through the whole atmosphere, would return somewhere near the gun in about an hour's time, whereas if it ascended entirely through the medium, and still retained motive force, it would go we know not how far. We are almost inclined to think it would never return, or at least, if it should, it would be days or perhaps weeks before it reappeared.

All these particulars are especially applicable to the ejected materials of any one of the rings, with the exception that they encountered the slightest degree of atmospheric opposition. We will, by way of example, suppose that Saturn's atmosphere is a hundred miles thick; but what was that in opposition to a world ten thousand miles in diameter, and with its materials ground to powder, spreading with lightning speed circular wave-like in all directions? They burst through the thin atmospheric barrier, with practically no opposition, into vacuo; and therefore, meeting with no opposing material force, the force was much more than sufficient to spread nearly, if not the whole, to the natural limits. The wonderful projecting force applied would have expanded the rings, or at least their materials, immensely wider, but a natural law prevailed by which they could only shoot out so far as to be free from gravitation back to the planet. They could spread out no wider, for taken collectively they ceased to be a grain of weight, when, of course, their initial impelling force became powerless upon them. In this state, when spread out, the circular ring-shaped ocean of particles had, although unconsolidated, within them an attractive force in common, much the same as if the whole had been solid together. Near the planet, or within a few thousand miles of it, their native force of attraction was the weakest; but as the projecting force was more than sufficient to send them through vacuo to almost any distance, they continued expanding at inconceivable speed, until they reached the point at which the attraction of the planet was the weakest, beyond which they could shoot out no farther, for, taken collectively, they ceased to be a grain of weight, when, of course, the initial propelling force became powerless upon them. Their motive force in vacuo without opposition was, while they were heavy, calculated, as they were going with meteoric velocity, to carry them to an immensity of distance; but the moment the circular flat cloud reached such a distance that the attractive force of the whole prevailed in opposition to that of the planet, a centre of attraction of a circular form took place throughout the heart of the unconsolidated sea of matter, and, instead of spreading out farther, all the particles instantaneously gravitated in obedience to stronger force, and very soon fell together into a perfectly solid annular body.

The time taken up in producing any one of these great formations must have been exceedingly short. We see the velocity with which the meteor approaches in a clear night, and the great world, although coming straight, fell upon Saturn with its loosened materials precisely on the same principles, but on the surface with an acquired weight ten times heavier than gold, and they rebounded in bulk,—the opposing atmosphere to such oceans of matter being as nothing,—wide and in equal proportions through vacancy to the required distance with lightning speed, beyond which the laws of nature made it impossible they could spread out wider. The work from the collision to the end only took minutes; but the gravitation of the particles of the ruined world into solidity was no doubt slower, yet, viewing it in any light, the mighty structure became perfection in a time marvellously short.

The rings, as they continued in succession to be formed, took concentric positions to each other, and this they still and always will hold. If the equator of the planet could be accurately determined, it would undoubtedly be found that it is in like manner concentric to or on the same plane with the rings. They h not this coinciding position when first formed. The collisions which produced their formations may have been at any angles of declination, but the rotation of the planet in time inclined them one inside the other, the equatorial line coinciding with the whole, just as the rotation of the sun on a larger scale has brought all his planets into a corresponding position. This, as a rule, must hold universally good in relation to all bodies, whether planets under suns, or satellites and rings governed in secondary condition under planets. The positions, therefore, which the rings hold inside of each other, while they exhibit above any other feature in the heavens the most beautiful proof of the wonders produced by rotatory motion, is no argument against their formation as described, for no matter how widely they as annular bodies may have at first leaned, in obedience to the governing rotation of the planet, it is impossible that they could hold any other than a concentric position.

When the materials of any one of the three bodies out of which the rings took form[*] were first spread out, by the force of collision, into an ocean of dust, it might be asked why it was that the motion of Saturn did not lead it to escape, and leave out the whole in the cold behind. It might as well be asked, why the planet cannot throw off the ring appendages that encircle it at present, for the rings could be as easily forsaken as their spread-out materials before they were consolidated ; and it may be added that it would be just as unreasonable to ask why the same motion of the earth does not leave the clouds, the atmosphere, and even the moon herself behind. If an object or body becomes once subjected, or rather drops within the attractive sphere of a larger secondary body, it can never be separated. As it happened, Saturn satellised during his existence seven planets, from which he cannot part ; and, however rapid his motion may be, even if it were increased a hundredfold, they would still move at an equal pace in faithful allegiance. In like manner, when the débris of ruined worlds were spread at various times into circular oceans round him, they, in their temporary loose scattered condition, were carried on by the great planet in its orbital motion, as the earth carries along with it, in its circular path, the atmosphere, and myriads of other floating objects. It was precisely the same with the materials before consolidation, and which now form Saturn's rings.

The rings are all uniform in shape, as much so as globular bodies compared with each other—unmistakable proof that the same operations repeated formed each of them. While, however, their shapes resemble each other, there is a marked difference between the thickness and quantity of matter in each, from the inner ring to the outer, each succeeding ring being thinner and more attenuated, and with a smaller total quantity of matter, according to the wideness of its expansion. Thus, to give our readers a broad idea of the three on a small scale, as far as can be judged the shape of the exterior ring may very fairly be compared to a circle of two feet in diameter, representing a belt-like border of about an inch in width, cut out of a plate of tin; its thickness to its breadth having perhaps about the same proportions as the thickness of tin to an inch. The middle ring, again, may be compared to a more contracted circle cut out of sheet iron, and is in its belt-measurement wider across than the exterior; while the inner one in massiveness may be an outline of quoit shape, but evenly flat, and with an opening in comparison wider.

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[*] From the first we have reasoned out the subject as if there were three rings. It is an open question whether there are two or three, but if we are in error in regard to the number, it in no way affects the reasons advanced on annular formation, seeing that they all took their existence from the same operations repeated separately in each case.

Another comparison of the rings to each other may also be made, which, if there is a grain of truth in our description of their formation, will represent truly what they are. Each ring, as it succeeds the other, is of the same shape, but in depth of rim narrower, and exactly in the same degree thinner as to its greater expansion. Supposing, for instance, after all there are but two rings, and that the rim-breadth of the exterior ring is 2000, and that of the interior ring 8000 miles, the latter would be thus four times broader. It must also be four times thicker, so that, in lineal measurement, the one body has in it actually sixteen times more matter than the other. However, according to the description of ring formation we submit, whatever may be their comparison, rings surrounding any planet as they succeed each other, must, step by step, be very much smaller as regards bulk of matter. Such a theory is applicable to Saturn's rings, no matter what may be their comparative magnitudes, and it must also be the same with the planet rings of other systems, for annular formation is not confined within our solar limits, but must, no doubt, be more or less common throughout the universe, but only within some of the largest systems.

The uniform shape of the rings, their thinness, their apparent decrease in magnitude in exact proportion to their greatness of expansion,—a rule which must hold good if they were formed out of the collided fragments of large worlds rebounding from the surface of Saturn,—and in all cases their thin edges, turned towards the planet, form together overwhelming indirect proof that these bodies must have originated from collisions, such as we have been describing, of destroyed planets, out of whose scattered materials they were formed. No other shape could possibly have been assumed than the thin circular laminated forms that we know the rings have taken from the nature of the mighty collisions which spread out their materials. Their successive decrease in magnitude, from the inner ring outwards, to any one seriously studying the subject, is equally conclusive, and to our ideas, every circumstance connected with these remarkable formations as a whole make up a body of direct and indirect evidence combined which establish the fact, that no possible natural operations could ever have united to form these annular bodies, except the repeated collisions of large planets, each planet in turn colliding upon the body of Saturn with the requisite force to spread out the materials through vacancy to the expansions of the respective rings.

CHAPTER VII.

HEAT.

WITHOUT light darkness would be universal "over the face of the deep," and the universe would be an invisible abyss, with its millions of worlds hidden out of sight. Subject to such a state of things, judging from our terrestrial experience, life and the things of life could not exist, but under the balmy influence of light and heat man rejoices, nature is glad, and the worlds are inhabited. It therefore becomes our pleasing task, according to "the light that is within us," to enquire, under two separate heads, from whence proceed these givers of life.

The subject of light will in another chapter be treated by itself, but it may be here briefly observed that, as an emanation taken in itself, it unquestionably comes from the sun. In all ages it has in like manner been held that heat descends to us from the same luminary—the conclusion resting on the comparison of solar light and heat with the same properties of fire. Thus, it is an accepted property of fire to produce both light and heat, hence the inference is natural and easily arrived at, that as heat always accompanies the light of the sun, he must be a great fire, or red-hot something, placed up in the heavens to impart light, heat, and life to the few worlds nearest him. Such have been the prevailing opinions of mankind from time immemorial, and the recent discoveries of science, instead of dispelling them, seems only to have strengthened the delusion.

To give one instance. The discovery of central heat has given rise to the hypothesis, grounded on the very rational idea that the sun and all his planets are by nature identical, and that at the first they were all balls of fire, of the brightest burning liquid, the same as the sun is still, each one shining with resplendent beauty. They were, of course, so far as luminosity is concerned, all brilliant suns; but the influence of time from the beginning has continued to cool them, and thus the melted liquid rocks of the planets, by reason of their smallness, have congealed at their surfaces into crusts that veil their lights from sight; while the sun, it is urged, because of his largeness, still retains the burning brightness of his surface, and continues to illumine the system with nearly the same original splendour. Such is the idea at present most generally received by the learned as to the heat that they suppose comes from the sun; but a distinguished livin mathematician, not feeling satisfied with such a view of the question, propounded a still more ingenious solution of the difficulty, to a certain extent based on the assumption that the aeorlites which constantly descend upon the earth are wholly composed of the meteoric stones these aeorlites are well known to discharge. Of late years, for instance, it has been clearly demonstrated that millions of the small collections of matter termed aeorlites fall upon the earth yearly; and as the sun is the grand centre of attraction, it is reasonably concluded that the earth can only catch a few drops of the shower of matter thus forever concentrating from every point of the system, and which descend thick and heavy equally over every part of his surface. The face of the sun being thus thickly paved with nothing but meteoric stones, from which countless millions of flint sparks are being emitted by the blows of the stony meteors coming in, the hypothetical conclusion is arrived at, that from these sparks the light and heat of the sun, the harbingers of life to his subject worlds, proceed.

One other hypothesis in regard to solar light and heat, and it shall be the last we will notice, is that the body and materials of the sun are as opaque and dull of colour as those of the earth and other planets, and that the heat and light we enjoy come not from the sun himself, but from a species of atmosphere hanging around him; perhaps elevated a million miles up above his surface. This kind of pall is taken to be of a white shining colour,—nothing, of course, connected with the sun can be black, except the spots,—possessed of a degree of heat beyond the power of imagination to conceive, and from these qualities the system is supposed to be warmed and lighted. The ingenious author of the idea has not indicated where the fuel that keeps up the heat comes from.

Many other suggestions have been hazarded upon the same subject, but the three above-mentioned ideas are those now most popular with the learned. Passing over the two last, it may be observed that the former, in the pretty well established fact of the interior heat of the earth, has at least a plausible colouring of truth to support it. It is supposed that the earth and the other planets have had time to cool and harden at their surfaces, and that the sun also would have been reduced to a similar condition but for the enormous magnitude of the greater fire, the time elapsing since the creation having been too short to produce any perceptible change in it. Unfortunately the idea, taken altogether, leans for support on too many principles taken for granted. We read that the sun was made to rule the day, and prior to his existence, darkness was universal; but if the hypothesis be true, all the bodies, not only in the system but of the universe, came at the fiat of the Almighty simultaneously into their highest state of perfection as brilliant suns. What a glorious galaxy, not of stars but of a hundred suns, must then have shone within our solar precincts! But alas, we are told that these were extinguished by the cooling effects of time, with the comforting assurance they give us that the light of the sun himself is slowly going out. The process is not to end even with the snuffing out of our own luminary; for the same teaching instructs us that the decay of light is going on with all other suns, which, if true, will once again reduce the universe to its pristine darkness.

Such a beginning and end would be universal if the light and heat that gives life to creation were at the mercy of the cooling process; but, like all the works of the Almighty, both these properties,—the givers of life to the universe,—were made to be eternal and unchangeable. Every natural law that man has discovered is by its simplicity sublimely beautiful, and made to last, in its Divine perfection, as long as the sun and moon endure; but the light and heat of the system, if they emanated from fiery substance, instead of being as everything that God has made, by nature everlasting, would be a perishable creation. Whatever, therefore, may be advanced on the subject, or however worthless it may be, we are justified on the soundest principles in rejecting the idea that the glorious light and heat, which cast upon the world such heavenly beneficence, proceed from a fire which is burning itself out.

All that has been in the past, so far as we are aware, advanced in connection with light and heat, has been based on the idea that they were the emanations of fire, and that the sun was the fountain. However universal this notion, it involves the absurdity that the qualities of fire can bestow upon the world its life, gladness, and enjoyment. Fire undoubtedly gives heat, but of a kind that only withers and destroys, while the heat caused by the sun delights the senses and makes nature rejoice. A comparison of the two is a contrast as wide as darkness and light, or life and death.

The extent to which the heat of fire can be felt is another powerful reason why the heat of the sun must be in its nature quite opposite, and have a totally different origin. Very few of us, for instance, but have witnessed large fires in towns. In every case, no matter how tremendous the conflagration, the heat is felt at a distance scarcely wider than the street, yet it is held that the sun, as a ball of fire of intense heat, gives us our noonday warmth at a distance of no less than ninety million miles. Now, if the genial heat we are accustomed to proceeded from the sun as a ball of fire, it would scarcely be felt at a million miles distant from the great body, so that not even the nearest planet in the system would feel its effects in the least degree. But even admitting that the heat received on the earth comes from the sun as a ball of fire reaching to so great a distance, it involves the fallacy that a wonderful coincidence placed our little globe on the happy line of the system, neither too near nor too remote, at which life could be tolerable. There are two other planets, Venus and Mars, which might have living beings upon them so constituted as to withstand the intense heat and cold of their respective latitudes, but on Mercury living things would be burnt to cinders, and rocks would become molten with heat, while in all the other bodies of the system nothing requiring heat for the support and enjoyment of life could exist. Here, again, creation is assumed to be imperfect, simply to meet our finite ideas of the unknown. Instead of looking upon the heat imparted as adapted to meet the wants of only one of the planets, the conclusion, although it would settle no principle, would be far more rational if it were supposed that the heat warming the earth, whatever it may be, is by nature constituted to diffuse an equal degree of warmth to all bodies throughout the system, also that light, which diminishes in intensity by distance, is of a sufficient brightness to meet all the wants of even the remotest planets. We might instance the example of the planet Mars in favour of this equalisation of heat on all bodies, wherever they may be. As a body—if we are to judge from appearances—Mars is divided into oceans and continents, similarly to the earth. Its heat, therefore, must be above freezing-point, otherwise no water could exist upon it; for with a lower temperature, which it must have if distance from the sun marks the degrees of heat enjoyed by the planets, its aqueous rocks would remain unmelted. It would therefore have no oceans, and the whole expanse of its surface would be the same as the moon—dry, uninhabitable land.

If asked for our definition of solar heat, we should be inclined to urge that it proceeds not from the sun, but is evolved on the earth itself, from a lower to a higher degree, by his light. From the sun as a body, whatever its condition may be, whether a ball of fire, a place where there is genial heat, or a mighty orb without atmosphere or heat, we from him receive no heat, but simply light, which element descending upon the atmosphere evolves from it that genial warmth that is the life of the world. The heat is contained in the atmosphere alone, but it remains unchanged at a certain minimum until interblended with the light, when the heat always present in it is raised to a higher or lower degree, according to its density, and the angle at which the rays of light descend upon it.

Such is a description, in the briefest possible terms, of the origin of the heat we enjoy, and all the facts can be as clearly established as any subject in science. Our experience, for example, of lofty mountains and the highest elevations man has yet reached, proves that there is a gradual decrease of heat. It is likewise conceded on all sides, that if it were possible to ascend high enough to surmount the atmosphere, there would be at that elevation no heat, but the light would be the same. Here again is established the fact, that the heat we so much enjoy cannot possibly be from the sun, but is simply awakened to a higher degree in the atmosphere by the presence of his light. The common report of men of science that there can be no heat in the moon, because she has no atmosphere, is perfectly correct; but the words themselves, if there be any meaning in them, do away with the idea that heat comes from the sun. Yet, while admitting that much, they at the same instant frequently assert—the ancient prejudice being master of their mind—that the sun is a mighty orb of fire extending his heat far and wide. If heat came from him, both the moon and space above the atmosphere would be warmed, and the lunar inhabitants would enjoy the same necessary heat, for the support of life, as terrestrial beings. Such are the abundance of facts forthcoming in proof of the theory we advance, and it is demonstrated by all elemental discovery and experience, both in the past and present. Wherever there is atmosphere there is heat, quite irrespective of light, and the normal heat natural to it is always high or low as to its density, and in its absence there is and can be no heat. In vacuo there is no heat; on the tops of the highest mountains there is little heat, because of the atmosphere at such elevations being in the same degree thinner, and it is a truth universally admitted, that if we could ascend above the atmosphere, we should find, while the action of the sun would be the same, there was no heat. If it was possible to visit the moon, should she be, as is generally supposed, without an atmosphere, we would undoubtedly find that no heat is there, yet the solar light is as intense upon her as on the earth. Our imagination might soar even higher, and fancy a journey in a straight line to the sun. First ascending from the earth, in piercing through the veil of atmosphere, every step higher we would find the medium getting thinner, and the heat in exactly the same degree becoming weaker —we are stating facts that all scientists teach—and finally, passing through into vacuo, there would be no heat. The nearer we approached the sun this total absence of heat would continue, while the light on the nearer approach would be getting brighter, even to the surface of the great body himself, and if he is without an atmosphere, it would be found that, instead of being a mighty ball of fire, his whole surface is composed of interminable regions of cold desolation. With such reasoning before us, fortified by the experience of the whole of mankind in every situation and clime, we can without hesitation pronounce that we receive no heat from the sun, but simply light, which has the effect of raising the latent heat inherent in the atmosphere to its various degrees, which performs such a wonderful and beneficent part in the bestowal of life and happiness to the living.

Atmosphere, to which thus we owe not only the breath of life, but in like manner the heat we enjoy, has many other wonderful peculiarities, which have only caught the eye of science in a limited degree, a few of which may be briefly noticed before entering more deeply into the subject. Its becoming thinner and thinner, like a comet's tail, until it finally ends in nothing, at a supposed elevation of about forty miles, is one of its mysteries. Attraction at such a height certainly gets weaker, but this cannot account in the least degree for the gradual thinning of the medium, as all other matter consolidates into nearly a uniform density under the like force, while atmosphere is not susceptible of being so acted upon, a fact universally demonstrated by its gradual rarefaction to nothingness as we ascend. Again, the manner that light acts on the atmosphere is another of its marvels. If, for example, we begin at the point where the atmosphere ends in the intervening space between it and the sun, although the light is of equal intensity, there is a total absence of heat, simply because there is no atmosphere to produce it. At the highest point of its elevation, and immediately where it becomes rarefied to all but nothingness, the lowest possible measure of heat begins, and as the light descends the heat becomes gradually warmer until the surface of the earth is reached, where the greatest possible heat is developed, but in degree higher or lower, according to the direction the light acts upon it. This is but natural. Atmosphere being the mother of heat, it follows that where it is most dense, the heat will be in the same degree stronger, but the manner in which it is influenced in the production of heat is one of its other wonders. Thus, the greatest possible degree of heat is evolved when the solar rays are vertical, and its warmth diminishes in proportion as they slant. In other words, the heat of the atmosphere is highest when the sun shines perpendicularly upon it, as in the tropics; and the greater the angle the sun leans from that position to the right angle or horizontal direction, the weaker it becomes. When the sun is in the last position, that is rising and setting, his light produces not the least imaginary degree of heat, and if he could only be made to stand still in that position, with his disc half in view, the cold would soon become as intense as if there were no sun, notwithstanding that his rays—in the wrong direction—would be beating on the atmosphere as at his noonday splendour.

From the last remark it is not to be inferred that a continued absence of the sun would lead to a total cessation of heat. No matter how bright he may shine, or what his position is to us, vertical or otherwise, if there were no atmosphere there could be no heat. The heat comes not from him, but on the contrary, wherever there is atmosphere there is always in a lower degree heat, whether the sun shines upon it or not. The mystery of heat would, therefore, be solved, if we looked to the atmosphere as its only source. What a total absence of heat would be, it will perhaps be for ever out of the power of science to arrive at; but there is little doubt, if it were possible to be where there is no heat, even with the benefit of an atmosphere to inhale, all kinds of life would be extinct. No such degree of cold, or rather total absence of heat, can be experienced upon the earth, even if the sun never shone upon it, for there is a minimum, or rather normal degree of heat natural to atmosphere, under all possible circumstances. As before observed, above the atmospheric medium there is no heat, but at the highest elevation, where it begins, there is the least possible measure of heat, which increases gradually to the earth's surface to a temperature—we are speaking of the heat natural to atmosphere, not the higher degrees of heat evolved by the action of light—we are unaccustomed to in these lower latitudes, but through the long absence of the sun, is common enough at certain depths within the frigid zones. Navigators have penetrated far into these solitudes, where for months the sun never rises, and where for some days, a couple of weeks at most, the heat previously raised in the atmosphere by his light gradually dies away down to a certain point, below which it never gets colder, although months may pass away before the return of light again raises the temperature. Under these conditions our sailors continue lively, healthy, and in the best of spirits, whereas if a total absence of heat could be reached by the long concealed presence of the sun, it is reasonable to suppose that life itself would be impossible. It is just such a temperature as these sailors sometimes experience during the long polar nights, that would prevail over the entire globe, neither higher nor lower, if no rays of sunshine ever visited us. Such a temperature, however low, must necessarily be far above a total absence of heat. That is the true normal degree of heat belonging to atmosphere in the absence of the vivifying influence of light.

It is at the lowest possible point at which atmospheric heat can descend—which is natural, and would for ever belong to it if no sun existed—that the province of light sets in, and the great variety of temperatures common to the whole world are produced by the manner in which it acts upon it, and from the simple law that the heat natural to atmosphere rises according to the angle of light upon it is due all the varieties that render the earth a paradise, at least to the small class of mortals who know how to enjoy it. The motions of the earth, no doubt, have the effect of giving us our years and changing the length of our days, but our seasons are in reality owing to the degrees of heat produced by the varied declination of the sun's rays upon the atmosphere. Without this provision our days would be equally warm throughout; the same burning sun would alike parch the equator and the poles, and the intensity of the heat at all seasons of the year would be without variation. There would, in the proper sense, be no seasons or variety of climes—all would be nearly on a dead level, and bring forth the same productions, so that there could be no such thing as the luxuries of other lands to add to our enjoyments.

We may now view the contrast, under the existing state of things. The Allwise Creator bestowed upon us atmosphere as one element of life, containing a certain degree of heat natural to itself, too low to give life—at least to the vegetable world, without which higher life could not be supported. To add perfection to His work He created another of the elements of life, light, to which we are equally indebted for existence, and, unlike the heat of fire, He endowed it with the power of raising higher the heat of atmosphere, according to the inclination of the solar rays acting upon it. Finally, the motions of the earth, but more especially its axial motion, render the Divine scheme complete, causing the angles of light to vary, not only in the day, but throughout the year; hence we have summers and winters, seed-time and harvest, and every variety of clime, from the burning tropics to the frozen poles.

Another wonderful property we think atmosphere possesses, although we must confess it is one of those questions admitting of very little direct proof, seeing that it is out of our power to personally visit the other planets to judge by experience—we refer to the supposed effects the light of the sun has in producing heat on the atmospheres in the different latitudes of the system, whether near or remote. All those planets clothed with atmospheres, if of the terrestrial kind, no matter how remote from the sun they may be, can under no circumstances be colder than our polar regions during their long nights. They, therefore, possess temperatures in which human life, if provided with sustenance, might exist. Here, then, the old question arises, as the light of the sun becomes more feeble in the greater distance, is the heat evolved by it in their respective atmospheres in the same degree lower. To put it otherwise, as the intensity of light must decrease according to distance from the sun, does cold in the same degree increase on the distant planets? Only let us admit such a rule to be universal, and we should find that nearly all the bodies of the system would be unfit for habitation, at least for a large proportion of terrestrial beings, and such a view being so antagonistic to the beneficent workings of nature we are led to believe that the upholders of it are in error. In holding an opposite opinion, however, we must treat the subject with hesitation, for our conclusions will necessarily rest on facts so limited that we must simply submit them for what they are worth. We have in reality little else than common sense as a basis—a species of proof which is often very convincing on subjects it is impossible to establish by direct evidence.

The position on which we take our stand is, that every body upon which the sun shines has a degree of heat bestowed upon it, according to the density of its atmosphere, no matter how near or remote it may be from the sun which shines upon it, for we regard it as one of the wonders of the atmosphere, that whatever worlds it may envelop, its heat is raised in an equal degree by the presence of light, quite irrespective of its intensity. Admitting this assumption to be true, the earth we dwell upon—and the reasoning applies universally—would enjoy exactly the same degree of heat, whether placed nearer the sun or outside the orbit of Neptune, if light, however feeble, reached it. These are broad assertions, and, as we have said, with little proof, except that common sense, the basis on which the idea in a great measure rests, instructs us that the works and laws of the Creator are all perfect. Human research can find nothing useless for the ends nature provided it. Heat and light are included among those elements of life which make the world habitable. Light all worlds enjoy, and it would be imperfection in the highest sense,—an apparent want of creative power to fulfil the purposes of Almighty Wisdom,—if light only raised the degree of heat suitable for the support of life on one insignificant planet, leaving all the others either to be burned with excessive heat or frozen with everlasting cold. So much for common sense—a commodity that often in the absence of other proof goes far to establish a truth; but even this view of the planets, irrespective of their positions, enjoying an equal degree of heat admits of some direct proof, but the facts, while they add strength to the idea, we admit are not sufficiently general in themselves to settle such a question. We can only produce two facts—namely, the earth in its greater and lesser distance from the sun at opposite seasons, and the oceans of the planet Mars.

Every schoolboy knows that the northern hemisphere of the earth is nearest the sun in winter, and at its greatest distance in summer, while to the southern half of the globe he is nearest in summer, and more distant in winter. Now, if any measure of heat depended on relative distance from the sun, the winters and summers of the southern half of the globe would be so much hotter and colder respectively than the same seasons on this end of the world, that human beings, exposed to such severe changes, could only exist with difficulty upon it. It is, however, well known that the opposite hemisphere is not in any appreciable degree either hotter in summer,—if anything rather colder, but that is caused by the local effects of broad oceans,—when the earth is nearest the sun, or colder in winter, the time of year it is at the greatest distance from him, than the same seasons in this hemisphere, where all the conditions are reversed. We have here then a difference of distance from the sun, in the positions of the earth at the opposite seasons, that, if heat, as is generally supposed, decreased as to distance from the sun, might reasonably account for at least 10 or 15 degrees difference of heat; but the fact that they vary in no marked degree in their temperatures is direct proof that whatever may be the distance of the earth at the various seasons it has no effect, at least, on it as a body, in the particular measure of heat imparted to it.

We have before referred to the continents and oceans of Mars in proof that as a planet it enjoys something like the same degree of heat as the earth, but that our argument may be more intelligible we must parenthetically make a few remarks on the existence of liquids.

If we exclude heat in nature we suppose there are no liquids. Wherever liquids are found to exist, whether it may be in oceans, seas, rivers, or springs, they are neither more nor less than solid rocks in a melted state. All rocks are reducible to liquid by the application of heat, but for the melting of different kinds various degrees of heat are required, and of all rocks those of aqueous formation are the easiest melted, the melting point being at 32°. When the temperature is below that figure, the aqueous liquid congeals back into its native solidity, in a crystallised state, to what is termed ice, and the melted sand or granite is reduced to precisely the same crystallised condition, the only difference being the degree of heat necessary for the liquifaction of each species of rock. The congealed liquid in the rough slab of glass has its exact counterpart in the sheet of ice, in appearance presenting little difference, each being made up of the melted liquid of separate species of rock, only that the one rock is easier melted than the other. Now, all the planets, including the sun, have been built up by the same natural operations,—which are still going on before our eyes;—and therefore the rocks which compose them, whether aqueous or otherwise, must be of the same identical kind of materials,—all derived from a common origin, so that in each of the planets the different variety of rocks may be reasonably looked upon to be in about equal proportion. But it is only those bodies among them which have received atmospheres that can have heat, and without which their aqueous rocks must remain unmelted; hence all bodies that are not covered with these mediums of heat can neither have seas or any other liquids on their surfaces. Our moon, for instance, may possibly have an atmosphere; but if she has, it must be so thin as to have no heat within it sufficient to melt her aqueous rocks, consequently, whether or not it may be from an insufficient or total absence of the medium, from these causes there is not a drop of water or other liquids over all her surface. If there were oceans on her surface, they could not be mistaken; and her largest rivers would show to us as fine threads of silver. As a body, if she ever does borrow an atmosphere dense enough to produce the requisite degree of heat,—at one time or other very likely,—her mountains would on a sudden partially melt into liquid, and her face become changed into seas and continents, in a time wonderfully short. The same forbidden features overspread the earth before it was covered with atmosphere; but the instant it was clothed in this its first mantle of life, the light of the sun evolved the degree of heat that dissolved its aqueous rocks, giving form to its oceans, whatever may have been their primitive outlines. In like manner, oceans and continents give infallible proof of the presence of atmospheric heat upon a planet, and also of a temperature not only sufficiently high to liquefy its rocks into water, but at all seasons to continue them in that melted state, so far as regards its main bulk of waters, its seas and oceans. Mars is so constituted. Its features clearly present grand divisions of a lighter and darker hue—the characteristic shades of land and water;—if these divisions, therefore, are really continents and oceans, of which there can be little doubt, it must as a body enjoy a degree of heat about on a level with that of the earth, although at such a greater distance from the sun that if its heat depended on the intensity of his light, it would be too weak to melt its aqueous rocks into oceans and preserve them in the liquid state, even with the help of its atmosphere.

The seas and continents of Mars, while they prove the presence of a terrestrial degree of heat, lead our ideas farther afield to Jupiter and Saturn; these bodies, although much more remote than the planet Mars, have discs so wide that continents and oceans should be distinguishable upon them, but they present a uniform colour, involving the conclusion that they are both without atmosphere. A body, for instance, composed entirely of dry land, if at a sufficient distance, presents an unbroken and uniform colour, and it is the same with the divisions covered by oceans. However, the belts of Jupiter constantly changing their positions should settle that point; besides it is next to impossible that either of these bodies can be without atmosphere, when we take into account the operations which have swelled them up to their enormous size. Worlds upon worlds have been incorporated into each, during an early epoch of creation, and many having brought with them their contingents of atmosphere, which in the aggregate no doubt have bestowed ample mediums upon them; still they both are apparently without continents, as they are unbroken by different shades of colour. Their uniform colour may be explained on the supposition that both are covered with endless oceans without a break, based on the hypothesis that each received, during the progress of creation, an equal proportion of aqueous matter with the other planets; —and if they all drew their materials from a common source, it cannot be otherwise.

In the outset, we take for granted that there are atmospheres upon these bodies keeping up a continual degree of heat, as upon the earth, and which hold their aqueous materials in a constantly melted state. The melted material, or rather water, is lighter than the rocky materials which make up a body, consequently it by nature floats at the top or surface, on the principle that the heaviest materials sink to the bottom. As water, therefore, from its lightness, after filling up the interstices, must be on the surface of a body, the larger it is the greater proportion will its seas bear to its dry land. The more it enlarges, the surface becomes less compared to the whole, till we can well conceive of a body so large that the surplus water would be in so great proportion on its surface as to cover nearly the whole. These huge overgrown bodies have actually attained such a size, it is therefore unquestionable, if they contain the same proportion of water as the earth, that they must be nearly covered with oceans, except it may be some solitary rocks—the highest peaks of Alpine ranges, which in odd places crop up from their watery solitudes. Over our own globe, for example,—the largest of the minor planets,—the water has so far gained upon the land as to already cover fully two-thirds of its surface, and so long as nature continues to add to it as a world, its oceans will enlarge still wider, while its dry land will actually diminish, by reason that its waters must rest principally on its surface. Judging from the different shades of colour, the proportion of land to water on Mars is, on the contrary, greater, simply because it is a smaller body; and applying the same rule to Jupiter and Saturn, the only conclusion to be arrived at is that unbroken ocean over all their surfaces must prevail. The tinge of colour produced upon them by the reflection of the solar light goes some length in proof of this assumption. In looking upon them, for example, between the belts, they exhibit in colour that darker hue which the oceanic divisions of the other planets present, entirely of one uniform shade with the exception of some odd bright spots barely perceptible, and which most likely are the solitary remnants of the land not yet covered. The white spots are not the only contrasts of colour in proof of these planets having almost entirely an ocean surface, the brighter colour of their moons, and the rings of Saturn adding further testimony to the fact. Thus placed in contrast their moons are all of a whiter colour, and from their smallness as bodies the greatest part of their surfaces may be presumed to be composed of dry land, hence the difference in colour. The rings of Saturn again exhibit a beautiful silvery brightness, in contrast to the darker ocean hue of the parent body, and these formations being nearly all surface, as compared to their bulk of materials, the sheets of sea upon them must be insignificant. This again, while accounting for their more brilliant appearance, is another reason in favour of the great planet being covered with an unbroken ocean surface.

The foregoing broad inferences, of course, mainly rest on the supposition—a very reasonable one—that all the bodies in the system are made up, in about equal proportions, of the same identical kind of materials. If they thus correspond in their construction, the dry land on those which are covered with sufficiently warm atmospheres must, as they increase as bodies, after attaining a certain magnitude—a measure of magnitude we suppose the earth to have long attained—in proportion constantly decrease in dry land. At last, if they should ever reach by continued growth the greatness of monster planets, their oceans will overlap all their lands, except it may be some of the most elevated peaks of their highest mountains, which would still show themselves as lone beacons over their watery solitudes. As regards the sun himself, if there is an atmosphere, and consequently heat on his surface, the quantity of water must be so enormous, that the highest mountains are submerged far below, thus presenting a boundless watery waste, without a spot to relieve the monotony. The spots which appear on his disc prove the very opposite of an unbroken ocean, and so lead us strongly to the conclusion that he has no atmosphere.* Besides, when we come to discuss the causes why the earth, and perhaps the majority of planets of a certain magnitude are possessed of atmospheres, if we are not in error we shall show that it is an impossibility that the sun could ever have received such a medium; and that, instead of being an orb of liquid fire, his entire surface consists of endless regions of dreary dryness over which there can be no heat.

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* Philosophers think they can discern atmosphere on the sun, but it is possible they may mistake it for the effects produced by his light on our own atmosphere.

CHAPTER VIII.

LIGHT.

In taking up the question of light *per se*, let us at once observe that we, of course, are profoundly ignorant as to its nature, and that it would be as difficult to define it as its kindred emanation, attraction; but we suppose both are properties common to all matter. In many respects there is a close affinity between them, but in their effects and uses there is a marked contrast. Attraction is a something felt but not seen, while light can be seen but not felt, and there is this further difference, that attraction can be felt in relation to all bodies that are centres of gravity, but light, while it is natural to all, can only be seen from a few—the sun and stars, the largest existing bodies. To both are committed the highest functions in the economy of creation. The universe is governed by attraction, and light gives it life—without the one, material nature would dissolve, and if there was no light everything would perish, and darkness, as at first, "prevail over the face of the deep." They each pervade the universe and are experienced by the whole of mankind, but their mysterious nature is beyond conception.

It is generally supposed that light reaches us more or less according to the breadth of surface it comes from, but our standpoint will be that it is in this respect the same as attraction, an emanation that springs from all matter, according to the magnitude of the body or bodies it comes from. Attraction we know is a property of all matter, and so is light, but the latter can only be perceived by the sense of sight, and the most intense lights are alone visible, blotting out, as they do, all feebler lights. In other words, as light is a property universal to matter, the same as attraction, all bodies are by nature constituted to send forth light as an emanation—in no way connected with their colour—but the lights only of the larger can be perceptible, because all other lights are feeble in the same degree as the bodies are small, and are thus obliterated out of sight by the splendour of the greater lights rendering perfectly opaque the smaller bodies. Their gentle flickering lights are thus blotted out.

Such is a brief definition of the manner in which the light or lights of the universe act and react on each other—truths which cannot be established by direct evidence, but they are, so far as the analogical testimony of the whole heavens go, capable of universal proof. What could be clearer in establishing the important truth than that—a fact all thinking men admit—only the largest bodies throughout the universe, in their various positions, are what is termed luminous, while all the others of sufficiently low magnitude to be subject to them are for the most part rendered opaque? Why is it that the largest bodies only shine and give light? The common effect produced is the answer. The lights of the smaller are feeble exactly in the same degree as they are of lower magnitude, and between our sun and the largest of his planets the difference is so immense that the glimmering lights natural to them are extinguished by the overwhelming splendour of his greater light. The principle by which their lights are put out by the eclipsing brilliancy of the mighty luminary will be better explained when we consider the effects which artificial lights produce on each other.

That every planet of the sun is by nature capable of sending out light will, no doubt, be very sceptically received, it being so much opposed to the evidence of the senses; but the real question remains: How is it that the largest bodies alone give light, and all others in a sufficiently lower scale are opaque? To say that they give light because of their magnitude would be absurd, and it would be equally irrational to conclude that they possess the luminous quality by virtue of their being governing bodies, and that the others are non-luminous because of their subjection. If any of the planets besides the sun were luminous, or if he were an opaque body and the system enlightened by one or more of the planets or satellites, then we could legitimately conclude that some bodies only are by nature luminous. The rule, however, is, that all the larger or largest bodies send out light, while all the others, without exception, are so acted upon by the greater lights, that their own feeble lights cannot show themselves. Thus is presented to us at a single view all the known bodies of the heavens—analogical proofs without limit—that the universal opacity of inferior bodies is produced by the obscuring effect of greater splendour shining upon them.

No one, trusting to the evidence of his senses, could for a moment believe that the earth under any circumstances would emit light; but if we examine the nature of the subject deeply,—the reception of the truth doubtless requires a considerable amount of credulity,—and take a comprehensive view of the heavenly bodies, we gain, as already observed, universal analogical proof in support of the important fact. No doubt, it is one of those questions which admit of no direct proof, it being out of our power to judge by experiment upon the planets themselves; but, supposing that our earth could be removed sufficiently distant from any other body or sun larger than itself, it would unquestionably send out a very feeble light, in brilliancy perhaps not exceeding a thousandth part of the splendour we receive from the sun. Such a change would produce no alteration in the colour or appearance of the earth's materials. To its inhabitants the beauties of its landscapes would be in all respects the same; besides, they would experience endless summer and perpetual day. Again, if we apply the same reasoning to the sun, whether he is or is not inhabited, it would be as absurd to affirm that the materials on his surface are luminous, and that it is from their luminosity we receive our light, as if we were to assert that the moon would retain in our eyes her colour of burnished silver if we were on her surface. In short, it is not the colour or appearance of matter which gives light, but a mysterious emanation—the same as attraction—which comes from it with an illuminating power equal to the magnitude of the body from whence it proceeds. The light which such a body as the sun sends forth, is in a certain sense overwhelming. It reaches us with a force that blinds the vision; but if we could only pay him a visit, we should find much the same dulness of colour in his materials as on the earth, and most likely in other respects of the same identical kind.

Everything that God has created is perfect. Light is one of His creations, and if it were in any degree partial, so as to endow only a select number of bodies with luminosity, the universal beneficence would be limited and partial. The bodies thus created to be the lamps of heaven would, of necessity, be so unevenly placed that large tracts of the universe would be devoid of that degree of light sufficient for life, and thus millions of worlds through the boundless regions of space by their unfortunate positions would be in irremediable twilight. Taking, however, the broader view of the question, that light like attraction is common to all matter, its inadequacy to enlighten the whole of creation vanishes out of sight. If all matter has light natural to it, when a world is created it cannot be in darkness—its name means light, it brings light with itself, and as one of the lamps of heaven spreads its light far and wide; but if it is a small body its light is in the same degree weaker, and another light stronger than its own from a larger body simply replaces it, and then, instead of itself shining, it is shone upon.

A lesser light can never exist in presence of a greater—a principle that applies to all the lights of the universe, and may be illustrated, very imperfectly, by the examples of small luminous objects, and the effects produced by brighter lights acting upon them.

If we take phosphorus as one example, we find that when exposed to the light it is perfectly opaque, and no matter can appear more unlikely to have shining qualities, but in the dark it always gives a feeble light, which even the gentle reflexion of the moon completely obliterates. In like manner a firefly shines in the dark with a most beautiful glare, but when in the presence of light its fire is quenched. These examples, as well as many other naturally luminous objects which could be mentioned, prove so far as they go that weaker lights are always obliterated by the presence of stronger. If the weakness of lunar reflexion is sufficient to extinguish the luminosity of the objects referred to, how much more effective the intense splendour of solar light to blot out the lights of the few bodies exposed to it, which are by comparison as grains of sand!

The naturally luminous objects on the earth's surface are, however, rather weak examples to reason from in regard to the effects that the greater celestial lights have of obliterating the lesser, and we must, if possible, elucidate the principle more clearly by the examples of artificial lights.

Suppose, for example, a number of candles were lighted at an equal distance from each other in a large room, each one, notwithstanding that the others also were alight, would only illumine the space halfway between itself and the next light, adding nothing to the light in any other part of the room ; but if there was no other light in the room, this one light would more or less illuminate the whole area. The room, as a whole, is much better illuminated by so many lights distributed over it, but the light round each candle for half the distance between itself and the nearest to it would not be the least increased or diminished by the other lights, and a person reading by its light, if all the others were extinguished, would still enjoy for his purpose exactly the same degree of light; and, without seeing what had taken place, would be unconscious of the change. Again, if a jet of gas sufficiently strong for the purpose were introduced, every candle in the room, although their flames remained, would instantly cease giving light, simply because the gaslight over the whole room would completely obliterate or rather usurp the place of their feebler lights. In the next place, if an electric light were introduced, the gas jet in turn would be rendered, in the scientific sense, opaque. Although the other lights are still burning, there is now in reality but one light in the room, the others being rendered as flames or substances opaque, as proved by their casting like other objects their shadows on the wall. Finally, the electric light in turn is rendered opaque by the presence of the sun. Ten thousand such lights, if exposed to the glare of the day, could neither increase nor diminish the surrounding light, on the principle that the separate lights of two or more bodies can never conjointly occupy the same place. Stronger light universally usurps the place of weaker light, and obliterates its visible presence.

These examples of artificial lights, and their action upon each other enable us not only to reason, but to confidently pronounce the sun and planets to be so many lamps in the heavens, spreading light over dark space, the largest only shining, blotting out with their glorious splendour all the innumerable weaker lights. Thus, in our system, the light of one of them, precisely as in the artificial lights we have mentioned, strikes the others with such overwhelming splendour that the feeble glimmering lights natural to them vanish out of sight in presence of the glorious halo. Even the sun himself would become, with all his glory, opaque, if the light of another larger body, stronger than his own, could reach his surface. Such a change would strip him of all his light, and then in every respect, except in magnitude, he would appear like one of the planets, silvered over with borrowed light.

We may pursue the subject to even somewhat greater length by having recourse to a novel mode of indirect proof, which to the studious mind may be more convincing than any other reasoning which could be advanced.

We might ask, What would follow if all the suns of the universe were suddenly annihilated? The unthinking would no doubt say that the lights of creation would be extinguished, leaving us buried in the blackest darkness; but no reflective or philosophic mind would for a moment admit that such great imperfection lurked in creation. Wise men would reflect that the instant our own sun vanished as one of the great lights, the four major planets would cease revolving, and, standing still, be suns themselves. Owing no allegiance to one another, they would, according to their respective magnitudes, spread their lights around, and it might be that an odd feeble sidereal glimmer might show from the largest of the minor planets. But, whether our earth, subject to such a change, would become sidereal or not, it would at once begin rolling round Jupiter as its sun, its luminous qualities in some measure depending on its relation in the system to that body at the moment of the great change. If shone upon by its new ruling body instead of being surrounded by its own native light, the light reaching it from so small a sun, and at such a distance, would, while adequate to meet all human wants, be extremely feeble; but under such a pale light, it is our belief that the same degree of heat would continue to be raised in our atmosphere as that previously engendered by the intense and brilliant splendour of the sun. Letting that, however, pass, we are inclined to fancy that at such a distance as Jupiter, while our globe would be necessarily subject to it as a planet, it would have as remote a relation as it would be to the sun, if in a position far beyond the orbit of Neptune, and therefore, like Herschel's double stars, its inhabitants under native light would lead an indolent existence, in the enjoyment of endless day. But whatever might be the change, we should still have light and heat, for, we repeat, where there is matter there must be light, and where there is sufficient atmosphere, the requisite degree of heat by the presence of light, however feeble, is produced.

If the suns of the universe were put out, our reasoning by no means implies that the other lights which would replace them,—although more numerous,—would be of the same refulgence; for, as the quantity of matter would be vastly diminished, to a certain extent the light of space would be reduced as a whole to a much weaker state. Suns, for instance, as a class of bodies, from the natural operations in force since the beginning of creation, have been one and all great centres of attraction, hence planetary bodies have in general been very slowly built up, while the main centres have increased ofttimes in their magnitude hundreds of

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times greater than all the planets subject to them. As suns therefore contain matter greatly in excess of all other created bodies, if their lights were extinguished others would undoubtedly replace them, but the heavens would lack their present sparkling splendour, and nothing brighter would cheer the celestial scenery than the petty glimmering lights of the telescopic stars.

We have more to add on the origin of light when we come to treat on the telescopic stars, but for the present we must pass from the subject, by alluding once more to the popular error which supposes that suns in themselves are luminous.

If we take the moon as apposite to the case, with our present enlightenment on the subject, it would be put down as a gross absurdity to maintain that, if we were on her surface, she would appear to us of the same bright colour as seen from the earth. Holding this in view, the conclusion would surely be equally irrational that the materials of the sun are luminous, on the bare evidence of the senses through being dazzled by his light. We are justified, therefore, in supposing that the light which comes to us has no relation to the colour of the materials, but that it is, what it has already been defined, a mysterious emanation which enlightens surrounding space, and spreads more or less out from all bodies; consequently if light, like its kindred property attraction, thus springs from matter according to its magnitude, the colour of the body giving it out can have no possible relation to the light produced. Indeed, for what we know to the contrary, the materials of the sun himself are of the same identical kind and colour as those of the earth and other planets; but, supposing they are different and of some unknown description, of which we can have no conception, and that they shine with the most dazzling brightness, the idea of the volume of light that surrounds us coming from a surface brightness, whether it may be from fire or anything which glitters, is preposterous. Human imagination could not account for the quantity of light we receive on any other principle than that it is a common property of matter, coming from it, we know not how, in brightness and intensity according to the magnitudes of the bodies from whence it proceeds.

The ideas we are thus submitting, we are aware, are totally opposed to the evidence of the senses, and run counter to the prejudices of ages. It may be that we shall be ridiculed for them, but, believing that we are right, we give expression to our views regardless of the consequences, or the great men in opposition to whom we find ourselves. Great men! what are they?—the shining lights of the world, who in all ages from their fertile intellects have elaborated the scientific errors of the past, by which the human mind has been long held captive. If, therefore, the giant intellects of history invented, taught and believed in systems of false philosophy, we may reasonably conclude that their modern representatives are not infallible. They are the last, although the most distinguished men of the time, we should be inclined to trust in dogmas of science or fancied discoveries, for, in reasoning upon the unknown, it is their besetting weakness to raise up philosophic structures on which momentous truths are made to rest, and which bear the stamp of finality, by the prestige of their names. Thus it is that the human intellect is poisoned, perhaps for ages, before the march of discovery explodes the errors invented.

To resume our subject, we may inquire whether, light being emitted over such a vast space from its fountain the sun, it is possible that such a dense exhalation of bright intensity could proceed from the surface of the mighty orb as a glittering or shining substance? No; if the existence of light rested on such a principle there would be none to cheer us, darkness would be supreme, and the sun, as a sparkling diamond, would at best be a thing of beauty to behold, and, as things are, while the moon sheds upon us a gentle reflexion, not a sparkle of light from the great diamond would reach us. As, therefore, the light we receive cannot spring from dazzling colour, and as it is absurd to suppose that such a heavenly emanation is the light of fire, we must revert to where we took our stand, by asserting that it is a something beyond our comprehension, which spreads itself out from the sun with a degree of brightness and intensity according to his magnitude. That the materials hidden within the orb can give light may appear ridiculous, but nevertheless that wonderful collection of matter, the sun, is there, and by his overwhelming glory entirely obliterates the feebler emanations of light extending from the bodies subject to him, so vastly smaller that the largest in comparison is but as one to a thousand.

CHAPTER IX.

GENERAL FEATURES OF THE SYSTEM.

THERE are three subjects, aerolites, telescopic stars, and the general features and imaginary outlines of our system, that in some respects might be continued as one, but which, beginning with the latter, we prefer treating under separate heads.

The extent of our system is, and perhaps always will be, an extremely vague quantity, for should astronomers ever be fortunate enough to discover the distance of the nearest suns, yet through ignorance of their relative magnitude the dividing lines will likely remain unknown. There must, however, be limits within which the attraction of the sun prevails, and in all directions beyond the same forces of other suns predominate, and whatever may be the distance of their dividing lines they mark out the true bounds of the system ; but for various reasons we will not at present enter upon the outlines, which must be very irregular. As regards the distance or distances, it is not given us to know, but we think they are much more circumscribed than scientists generally suppose.

We know one fact, that the system must be as wide or wider than the extent to which Halley's comet reaches, it being one of the very few comets permanently held by the sun, and at the greatest distance to which it reaches his attraction must there predominate, otherwise in its course it would be caught by some other sun, and, like most all such visitors, perhaps lost to us for ever. Now, given the time of its revolution to be about seventy-five years, we can easily arrive at its mean distance from the sun—our reasoning here applies Kepler's laws of motion to comets as well as planets—not to be far below that of Uranus, and as its approach at its perihelion is in comparison very near, at its greatest distance it must be, roughly speaking, considerably above three thousand million miles from the sun. Here is a minimum extent to which we are mathematically certain that the sun holds absolute sway, but the maximum distance to which his rule expands it is impossible, except in a vague and unsatisfactory sense, to determine. If the time ever comes, however, that the nearest suns to our system will be discovered—discoveries we suppose not impossible—we may then be enabled in some measure to arrive at an approximation of the truth ; besides, by one rule we can judge that human knowledge has already surveyed a considerable portion of the expanse. We refer to the well known gradual decrease in the quantity of matter from the sun outwards, as far as the system is yet explored, not including, however, the minor planets, for in a general comparison of the total in the natural divisions they count as nothing. Thus, as we recede step by step from the sun, leading to Jupiter, Saturn, Uranus, and Neptune, if we measure the sphere of space cubically, the quantity of matter compared to the whole dwindles in a gradually decreasing ratio for the whole distance. And supposing the decrease to be the same in the unknown space of the system beyond the last-named planet, it might be reasonably concluded that if this is not actually the most distant body, it is at least the most distant major planet there is, and that there are no more of that class in remoter space subject to the sun. If it is therefore the remotest planet, its relations with the border systems may be made clearer by comprehensively viewing the system as a whole, subject to the theory that matter decreases in quantity from the sun outwards, till at last, if we consider the immensity of space involved in the outer portion of the sphere, it ends at Neptune, in proportion insignificant.

The supposed comparative nearness of that planet to the solar borders may be made more intelligible by viewing in the mind's eye what the system may be as a whole.

Beginning with the sun, we must look upon him as the great common centre into which the atoms of creation from every surrounding point over the expanse have continually fallen from the first. Thus in the order of creation, in common with other suns, he took the lead, and became a globe of grand proportion, but very greatly below his present magnitude, before any of the planets, minor or major, had attained the diminutive dimensions of the smallest asteroids. This start in creation at the first dawn of planetary formation at once constituted him as the common centre into which nearly all created matter, in its atomic or aerolitic state, from that time to the present has been gravitating, and thus so vastly adding to his magnitude that all his subject bodies taken together are next to nothing in comparison. Causes, but of a different kind, which have given the central orb such preponderating magnitude have been the means, in a sunward direction, of collecting matter in largely increasing proportion in every one of the grand steps of the system. The system, in its entirety, for example, in regard to bulk of matter, naturally divides itself into five steps or divisions. First, we have the sun, which, as one far surpassing all the rest, owes its superiority to the others in common lying nearly on the same plane, and thus enabling him to draw nearly the whole into himself; next, Jupiter and Saturn, Uranus and Neptune, follow in order.* Jupiter, the first step out from the sun into the system, is the largest of all the planets; yet, measuring the narrowness of the sphere at so comparatively limited a distance, and the more contracted space over which his attraction predominates, the total extent of area in his annual rounds and subject to his command is not a hundredth part of what is swept by the succeeding planet, which, even if its rings and satellites are included, still falls short of the magnitude of the former. In other words, if both these planets had been enlarged according to the area of space at the command of each, Saturn would have been perhaps a hundred times the largest of the two; whereas Jupiter is at least on an equality through its more favoured position, as being the first step from the sun, towards which all matter is naturally inclined to concentrate. Next comes Uranus, which is not a tenth part of the magnitude of Saturn, yet the space naturally appertaining to it is vastly greater. Neptune is last in the series, a body considerably larger than Uranus, but the immense region of space, spherically, it commands in its annual rounds, if it had laid hold of all the matter which from the beginning originated therein—at least that portion which nature saves from the grasp of the sun for planetary formation—it must have been made up of no less than two-thirds of the total materials that form the other planets. Its magnitude, however, is only about a tenth part of the whole; consequently through these remote regions the quantity of matter to given space is reduced—a gradual reduction from the sun outwards—to insignificance, in fact, to not more than a thousandth part of planetoidal material if it had held its fair proportion according to the extent of area in the different latitudes.

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* There are numerous other known and unknown planets existing in the system from the size of the earth downwards, but as we are considering the relative bulk of matter as we recede step by step from the sun, as musket balls hanging in suspense compared to cannon balls, they are so insignificant that their addition or substraction would in no material respect affect the comparison of the whole taken collectively in each division.

This decadence of the quantity of matter as to distance can be accounted for if we but turn our eyes to the streams of new creation flowing from all points towards the great attractive centre, but which, from natural operations constantly at work, it is impossible that the whole can reach. The proportion held back, and which eventually adds to the bulk of the planets, increases in quantity every step nearer the sun. The latter body, from his commanding position, draws in by far the greatest quantity; but the planets all receive, so far as regards gravitating atoms and particles up to aeorlites are concerned, a share in proportion to the expanses of their attractive spheres and their proximity to the centre. These streams of falling invisible atoms and particles actually begin to descend sunward at the borders which divide the system from the precincts of the nearest suns, hence the exterior planet of the system, whether it may be Neptune or a remoter one unknown, is in part made up of the matter generated by nature within his attractive sphere, and none of which can fall to the sun. The wide expanse over which the attraction of this planet predominates—the more distant from the sun a planet is, the wider is its attractive sphere—may be looked upon as sufficient to account for a considerable fraction of its bulk. Receding to the next great secondary centre nearer the sun, the matter originated within its precincts has been proportionately less, owing to its narrower sphere of attraction; but it is in a latitude* wherein planetoids have had time to form, and, if formed in the same latitude, to become part of itself. These planetoids, including an extremely limited proportion of small asteroids, are naturally formed in vastly increasing numbers every step nearer the sun, but being mostly all destined eventually to add to one or other of the great planets. These huge planets are, we suppose, principally made up by the incorporation of such small bodies, according to the latitude in which they happen to be. And, as planetoidal formation naturally increases according to the lowness of latitude, it is sufficient to account for the accumulation of matter so vastly decreasing in proportion to given space as we recede from the sun.

The reasoning is based on the supposition that there is about an equal quantity of matter generated in all space within the system: it then would naturally follow that from the very small proportion of planetoids left by the great centre of attraction in the vast region or circular zone traversed round by the attractive sphere of Neptune, there is some ground for concluding that it is the most remote major planet within the system. If so, his sphere of attraction very likely touches the confines of other solar systems—their centres, of course, are much more remote—and if it is not the last of the series, the next in succession, judging from the known intervals between the other great planets, cannot be less than from one to two thousand million miles beyond. To explain this would be prematurely entering into the subject of the natural relations which, through creative operations, the planets are made to hold to each other, and which for the present cannot be fully entered upon. We, however, may cursorily allude to the principle by referring back to the spheres of attraction, more or less expanded, surrounding all the planets and other bodies in their relations to the sun.

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* The term latitude, to imply in a vague sense relative distance in the heavens, has been and will be frequently used in this work, and it may be worth while observing that if degrees of latitude and longitude were more commonly used in the teaching of astronomy, in a scientific sense, they would be almost as serviceable to it as the same subdivisions are to geography. If, for instance, within our solar space a distance of fifty million miles—or any other convenient number—from the sun were taken as one degree of latitude, the author of a school book could briefly indicate the distances of the leading planets as follows: Mercury 37′, Venus 1° 18′, Earth 1° 45′, Mars 2° 46′, Jupiter 9° 45′, Saturn 18°, Uranus 37°, and Neptune 60°. Such a simple formula would comprehend as much as could be expressed in a page by the usual system of teaching, besides abridging the labours of the student and imparting to him a clearer conception of astronomical distances within the system.

Fifty million miles might be a convenient unit for a degree of latitude within the system, but if applied to the distances of the stars or other suns a difficulty would arise which could be met by dividing celestial degrees into two classes, termed solar and stellar latitude; the former applicable to distances within the system, and the latter to the distance, or supposed distance, of the stars. Fifty million miles might be made to constitute one degree of solar latitude, while the most distant discovered point in the system, say three thousand million miles, would be a natural unit of measure for a degree of stellar latitude. Thus by using the distance of the remotest known planets as 1°, the supposed distance of the nearest stars would be of much easier comprehension than the array of figures usually taken to represent their all but infinite remoteness. We are told that no one of them can be nearer than 20,000,000,000,000 miles, but the enormous number put down in such a shape only leaves the mind bewildered, whereas, if expressed in stellar degrees, it would be 6,666°, a large number to deal with in itself, but yet to the average intellect easily understood, as the student would at a glance understand that the remoteness was no less than 6,666 times the distance of the planet Neptune. Such would be the utility of stellar latitude, as applied to astronomy in its present condition; but if the time should ever come when the distances of the nearest suns will be known, the division of starry space here hinted would be of greater importance. Take, for instance, the case of an astronomer whose good fortune led him to discover the distance of some particular star to be 3,000,000,000,000 miles, which remaining so expressed is as bewildering as the former number, but, if put down 1000°, the latter figures would at the instant be comprehended and the distance easily understood.

Beginning with Mercury, the planet nearest the sun—not so near as to be without a sphere of attraction, or, rather, it is an attractive centre by reason of the attraction at its surface being stronger than that of the sun, which saves it from gravitating into him—the extent from itself over which its attraction predominates, because of its close proximity, must be very limited. Venus again possesses a very narrow area within which its attraction is stronger than that of the sun, yet it is of much wider extent from its greater distance, while the attractive spheres of the earth and Mars, according their respective magnitudes and distances, extend still wider.

With regard to Jupiter, we should imagine, for we have no certain facts to go upon, that the expanse over which his attraction prevails cannot be much less and may be more than fifty million miles in diameter. Our calculation is vaguely based upon the nearest of the asteroidal orbits—only a few of which are yet traced—to the belt of space swept round by Jupiter's attractive sphere in his motion round the sun. The orbits of all the asteroids must be necessarily clear of that space, for if any touched it they would long since have been incorporated with the planet. Hence, as these liliputian worlds are so thick and numerous, whichever of their orbits come nearest clearly mark the extent of his sphere of rule.* Although, as we have said, our estimate is framed in ignorance, some such diameter in grandness of expanse must belong to the attractive sphere of the great planet, and taking this broad but undefined basis, we can now pass on to Saturn, a body, including its appendages, of nearly equal magnitude. Being at about double the distance from the sun, we can safely pronounce the expanse of its sphere of rule at no less than twice the diameter, whatever that may be. The area must be of great extent, as is proved to a certain extent by the attractive sphere of the earth, which is much nearer the sun, and by comparison insignificant, yet we have proof based on mathematical certainty that its attractive sphere can be no less than half a million miles in diameter. Uranus is next, at double the distance from the sun, and although a much smaller body, yet, from its great distance, its attractive sphere may be nearly as wide as that of Saturn. The last discovered planet, Neptune, is removed by a still wider intervening space, and at such a remote position the attraction of the sun must be very feeble. In the same degree that the attraction of the sun is weak, so this body must have a wider expanse of predominant attraction, the extent of which, roughly speaking, may be quadruple the expanse of the attractive sphere of Saturn, although the latter as a body is much larger. It is on comparative nearness to the sun that the foregoing reasons are principally based.

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* Not one of the asteroids could permanently exist if they touched in their annual rounds any part of the space swept round by the attractive sphere of Jupiter, and in an extremely minor degree the same is applicable on the other side in relation to Mars. It must, therefore, be held as indisputable that all these small asteroids move, as far at least as Jupiter is concerned, round on a clear space, never touched upon by his attractive sphere on the one hand, or that of Mars on the other. Their innumerable orbits have thus an unappropriated belt of the system to themselves, and if the nearest approach of any one of them to the orbit of the great planet could only be ascertained, the expanse of its attractive sphere could be marked out with a near approach to accuracy.

In the next place, that we may have a faint idea of the wonderful and important part these four great planets act in the economy of the system, let us suppose what most likely never happened: that they are all at the same time in mutual conjunction on one side of the sun. Being in such relationship, if attraction was a property which could be seen, we should then behold their respective spheres of rule widen according to the distance in their positions, while all being on a line, if not touching each other, they would at least fill up with their continued spheres of attraction the whole line of space so closely that no other independent bodies could permanently exist in the intervals. Large bodies, as they generally move on orbits nearly circular, might move free in the intervals; but, as a general rule, small bodies move on much more eccentric orbits, and allowing for this, no matter where placed, they would touch at some point or points upon the spaces the revolving spheres of attraction of these great planets pass round, and be thus eventually caught and incorporated with them. Most likely there exist, even over the same regions, bodies from planetoids up to a larger class; but in any possible position from Jupiter outwards, or, for that matter, anywhere in the system, they cannot remain permanently so, and when the time comes that these recent creations are caught—and they are always laid hold of whenever their orbital motions lead them within any one of the above great spheres of attraction—they are either incorporated or—what in extremely rare instances happened in the early stages of creation—become appended as moons. In regard to this latter class of bodies, we suppose that they all originated simultaneously with the planets themselves; but we must bear in mind that the operations of the past which bestowed upon them their moons are still in full play. Small lunar bodies might, therefore, be added to some of the great planets in the future, but, for reasons we will not here enter upon, it is almost certain that such will never be the case. But whether or not, in the existing perfected condition of creation, additional lunar bodies might in the future be appended to these great planets, in other respects they are to be looked upon in their several positions—each one wide out from the other in the system—as four great secondary centres of attraction which seize upon a certain proportion of gravitating matter that stumbles within their attractive spheres in its descent to the sun. But much the largest proportion that goes to their enlargement comes in as planetoids, the lowest class of independent bodies which by their orbital motions alone and not by gravitation are innumerably led into their power and incorporated. The operations that have formed, and are continually forming these invisible and insignificant but independent bodies, planetoids, and which are constantly adding bulk in vastly greater proportion to the major planets, may be thus briefly noticed.

The primal creation of matter is always in the atomic state diluted thinly over space—a work that is still going on as in the past. The instant it exists it begins, except when within the secondary attractive spheres, to descend by gravitation to the sun, and at the same time it revolves—all matter, be it atoms or worlds, must revolve if within the rule of a rotating body—and this latter motion leads the atoms to unite, and in some instances to increase into aerolites. The aerolites in turn, being still subject to the same motions, mutually combine, and in rare instances attain the magnitude of planetoids—that is, collections of matter large enough to be attractive centres. The instant they are thus constituted as independent bodies they cease gravitating to the sun, but even then, owing to their orbital motions, it is their common fate at some time to be incorporated by the primaries, but more especially the major planets, which, by their wonderful influence in a secondary degree over the system, attract nearly all new created formations into themselves, not by the magnitude of their bodies, for that has no direct influence in the work, but by the sweeping power of their enormous attractive spheres, which move round the heavens with broad expanses as so many nets, securing within their meshes nearly the whole of the matter raised by magnitude above the perils of gravitation captive into themselves. From the nature of the question, Jupiter, Saturn, and, in a lower degree, Uranus, must have been largely made up of these planetoidal formations and larger collections of matter, for, like aerolites, planetoids are equally liable to combine through their orbital motions bringing them together, but it may be observed that neither these small bodies nor any others can mutually incorporate while they severally retain their attractive centres. This, when coming into collision, they will do except they differ considerably in magnitude. Finally, Neptune, if it really is the exterior planet in the system, unlike the other three major planets, has probably been to a certain extent made up from the atoms which for all time nature has generated within its wide attractive sphere.

Having thus advanced reasons in support of the very great probability that no minor independent bodies from Jupiter to Neptune can permanently exist—notwithstanding that they as planetoids are constantly being formed—we are in a better position to show that if any planets subject to our sun revolve in remoter space, we can only hope to find them after passing a wider interval than exists between any of the other great planets. As already observed, the supposition is at least analogically proved and corroborated by the intervals continually getting wider between the planets we have named, that if any planet or planets exist in remoter space, they must be so much farther away as to nearly double the diameter of the known system, if we are to judge from the other planets which, as they follow in succession, with one exception only, add twofold to the distance. Thus the first step after Jupiter is Saturn, about double the distance of the former from the sun, and Uranus is twice the total distance of Saturn, while in the last known step of the system the expanse is certainly not as in the other cases doubled, but it is extended considerably more than one-third. These wider and wider intervening spaces are caused by the respective spheres of attraction becoming more expanded, which they must do, as the distance increases, to enable them not only to monopolise all the planetoidal collections of matter, but to prevent separate minor and independent planets from permanently existing within their grasp in their respective regions of solar latitude. In fact, the great expanse from Juno outwards is the undisputed domain of the four bodies. They exert a sweeping power, rendering it impossible that any other independent bodies can exist, except for a time, in the intervals between them. The nearest primary planet subject to the sun in remoter space cannot then be discovered at less than the distance of Neptune from Uranus, and probably, from the circumstances we have mentioned, the distance might be twofold, considering the successive order of the others. All these facts argue strongly in favour of the idea that Neptune is the remotest primary of our system.

Our principal reason, however, for supposing that there can be no great planets beyond is not the immense distance they must be in, but, as previously observed, the known decrease of matter as to given space as we recede farther in the system. This, as a common effect produced, must be equally common to all great solar systems which contain secondary bodies, as each sun from the first became a great centre towards which all new created matter within its precincts naturally gravitated. Each sun sits in a central point of its own dominion, and by its attraction generally prevailing over the area there is a shower of new created matter from invisible atoms up to aerolites from all points round the sphere for ever coming to it. Thus suns, as their share, draw in nearly all creation, but not the whole. The attractive spheres of the planets in their various positions intercept some of the drops of the shower as their respective moieties of gravitating creation ; but they receive—at least the major planets—a far larger proportion, as planetoids, not one of which ever descends upon the sun. These planetoids, which eventually become incorporated with the planets—we suppose them sprinkled invisible over the system in millions—are in reality overgrown aerolites, so enlarged by mutual combination through their revolving motions as to be centres of attraction, and therefore temporarily independent bodies. As they are all therefore fortuitously enlarged to independence, taking the system in grand divisions, they naturally increase in number and magnitude in every step nearer the sun. Hence, as we recede out in the system, matter compared to the extent of space gradually decreases till we reach the remotest point of discovery, Neptune. The quantity of matter there saved from the grasp of the sun has dwindled down so near to nothing that what nature generates within the attractive sphere ruled over by that body—which it is reasonable to suppose may be five hundred thousand miles in diameter or more—would account for a considerable part of his bulk. If, therefore, nature has in a certain measure made up that planet out of matter originated within his precincts, it argues much for our theory that it is the exterior planet of the sun, but, while this may be so, it by no means follows that the directions of its periodical course lie near to the borders at all points up to which our solar attraction prevails. Possibly telescopes may yet be constructed to clear up these mysteries. May be, then, planets will be discovered far beyond Neptune, for it is to be supposed that worlds in reasonably close succession exist through all the visible portions of the universe ; but, when they are discovered, they will doubtless be found at a much greater distance than a thousand million miles, nor will they be bodies subject to our sun, but the outside planets of some of the numerous suns or sunlets which we imagine border upon our own system.

If the foregoing observations be true, it would be in vain to expect other splendid discoveries in the future to be made within our solar precincts, because from their natural relations the space outwards from Jupiter must be taken up, wholly on account of their widespread influence, by the four major planets. The last of these, as frequently observed, may be the one which describes the outer ring of the system ; but this is no reason why there should not exist over the vast extent a great number of small independent bodies, mostly planetoids, up to the size of a few very small asteroids. Whatever may be their number they are of recent creation, and none of them can as separate bodies for ever remain unincorporated. It is such a class of bodies, in reality overgrown aerolites, which in the past have most undoubtedly in great measure made up these great planets, or, in one case out of millions, became appended to them as moons. The same operations are still in full force, so that we may naturally conclude that as matter continues to originate, about the same number of these small planetoids exist now as in the past, and have existed since the termination of the chaotic period.

Their first state was invisible atoms, which accumulated by revolving motion into aerolites, and these last fortuitously combining, the planetoids that were the nuclei of the great planets we are treating of were formed. Of the millions of planetoids in this primal condition of matter spread over the regions in question, four in their several latitudes took the lead, as it was natural that some should do. Thus they were enabled to increase above the others step by step, till in the end they became in their respective positions the grand planetic centres, incorporating all matter which as planetoids came by their motions within the circular belts of space swept round by their attractive spheres. The planetoids themselves, which may be looked upon as remnants of matter by their fortuitous enlargement into independence, spared from the great absorbing power of the sun, are continually forming, and of necessity must continue to form until the creative epoch terminates. During their independent existence they revolve round the sun the same as larger bodies; but, being numerous, they occasionally drop into each other, and thus become compounds or greater wholes. Thus before they are caught some few may attain a considerable size, but in the present settled condition of the system the great majority no doubt fall into and increase the parent bodies as simple planetoids.

These minute and invisible independent bodies, to which the great planets owe so much of their enormous bulk, may in some instances be millions of years revolving round the sun before they are finally caught, still remaining, after such a prolonged period, enlarged no higher than planetoids; while a few others, after being spared so long, might be increased to the status of small asteroids of the invisible kind. Our reasoning, however, must for the present be confined to planetoids, the next step in the creative scale above aerolites, the lowest class of independent bodies, we suppose multitudinous in number, but quite invisible even to the telescope. What constitutes a planetoid may be still further explained as follows.

Of their formation from atoms we need not now enter upon, having already mentioned this part of the subject. So soon as the planetoid is formed, neither the attraction of the sun nor any other material force can impose gravitation upon it. To reach the first step of independence, however, its magnitude as a body must in all cases depend upon its position in relation to exterior attraction acting upon it. If it is in a latitude where the sun's attraction is strong, as a planetoid it must be large, but if its lot is cast where the same force is weak, it may be in an equal degree smaller and yet independent and safe from the perils of gravitation. What may be the real size necessary to constitute such bodies in any given latitude, of course we cannot determine, for we are without data to reason from; but in the opening chapter we took an imaginary body, B, using it as an example to demonstrate the the total absence of weight in matter, when not acted upon by any stronger attraction reaching it than its own. That body we took to be no larger than a good-sized hill. Such a size may be either too small or too large to represent a planetoid, but it is something like the magnitude we suppose a body in the lowest step of independence would be in this part of the system, wherein the attraction of the sun is comparatively strong, but if in the asteroidal zone we should very likely find a considerable number of these little bodies as much smaller as his attraction is weaker. Going farther from the sun into the region of Jupiter, his attraction gets still weaker, and planetoidal formations there must be in the same measure smaller. Thus, if we in imagination travel to or beyond the orbit of Neptune, the solar attraction at such a distance would be very feeble, and, if it were posssible, planetoids could form in a position where the outside streams of invisible matter begin to flow sunward—a collection of matter, figuratively speaking, no bigger than a man's hand, would be an attractive centre in itself, and therefore a planetoid. Being such, the solar attraction could have no power of imposing gravitation upon it to draw it nearer.

CHAPTER X.

AEROLITES.

When speaking of planetoids we are in a sense reasoning only on imaginary bodies, yet they must undoubtedly exist in thousands in remoter portions of the system, and it is likely enough that some of them may be revolving round at or near the latitude in which we are in. They are imaginary in this sense, that they are too small to be seen, except it may be possible that the nearest of them might show as telescopic dust, each atom of which is put down by astronomers as suns of wonderful magnitude, situated in space unconceivably remote. Whether in this appearance any of them are visible or not, they are in a lower degree as aerolites daily adding to the bulk of the earth by the million. These aerolites themselves are embryo worlds, differing only in the one important respect that, not being centres of attraction, they are too infantine to stand alone, but in all other respects the same, simply planetoids or worlds below the level of independence. They begin as the largest worlds at their first step of existence did, in remoter space, as invisible atoms, and reach this lower latitude in their gravitating descent towards the sun, accumulated into greater or lesser collections of matter. When these first come into existence they have their revolving motions round the sun like the largest planets, and, according to distance, neither quicker or slower, but in common with smaller objects, gravitate, while the larger do not; hence the former have both revolving and gravitating motion in the solar direction.

As a great proportion of matter within the system, from its primal atomic condition, has to descend thousands of millions of miles, the revolving and falling motions of the atoms lead them to unite, and as such a long gravitating descent cannot take up less than a period of years, during such a time by re-union at every step the atom becomes a particle, and particles by the same movements in turn join together and increase to aerolites, formations from which the earth, if we are to judge from modern discovery, has been in great measure built up. As these bodies, or rather objects, must therefore have increased from invisible atoms, in the nature of things some chance ones in their fall to the sun become so much enlarged as to have sufficient inherent attraction to become small centres of gravity. They then insta cease to fall to the sun, but retain their revolving motions, and continue on orbits exactly as the largest planets. They thus in reality become little worlds in themselves, and in some instances may remain independent for long periods of time. Their bulk under these circumstances is liable to be increased by other planetoids and smaller portions of matter uniting with them, until at last, in rare instances, some may become enlarged considerably above planetoidal size, although in the end nearly all are destined to be incorporated into one or other of the major planets, except in occasional examples where some—having attained the requisite magnitude—may be appended as moons; but in the present matured condition of creation this is very unlikely, and the conclusion is therefore much more natural that most, if not all, the lunar bodies came into being in the planetoidal state simultaneously with the planets. Three, at least, of the major planets have been principally made up by these small bodies, but all the others had a share, small though it may have been, of the streams of aerolitic formation constantly flowing from all points of the sphere to the sun, in addition to holding that which no other material force could deprive them of—the atoms of matter generated within their attractive precincts.

There is one body in the system, the sun himself,—and the only one of respectable magnitude,—which never has been increased in bulk by a single planetoid or anything larger than an aerolite, and this because no collections of matter, increased up to planetoidal magnitude, can be drawn nearer by the force of his attraction, and that, for want of revolving motion, is the only force available to draw created matter into himself. Neither has he power to lay hold of a particle of matter within any of the secondary systems, while the planets, on the contrary, are constantly enriching themselves by the materials they entrap from the dominions of the sun. In short, matter, whether it may be atoms, aerolites, or worlds, may be reduced under secondary power, but when thus brought under, it can never escape out again under primary government. In the various grades of government, governed bodies may sink lower, but they can never rise higher. It is on this principle that planetary formation principally rests. But the proportion of planetoids which planets thus receive in the various latitudes of the system from under the direct rule of the sun, as compared to atomic matter up to aerolites, we presume widely differs. If, for instance, Neptune is the outside planet, which we suppose it to be, it is likely made up almost entirely of atoms and small portions of matter up to the size of the smallest visible aerolites, because its position being on or comparatively near the beginning of the stream of atoms, they have had no time by mutual union to become enlarged in any material degree before passing the same latitude by gravitation to the sun. Planetoids may no doubt occasionally form there, but the attraction of the sun being at that distance so weak, they cannot be larger than the smallest aerolites which make their presence visible in our atmosphere. Uranus is a thousand million miles nearer, and with such a distance for the descent of matter the planetoidal region may be said to be fairly entered into. Therefore, we presume that this planet owes very much of its magnitude to the incorporation of such small formations. Again, in the circular zones of solar latitude, governed by the attractive spheres of Jupiter and Saturn, we are within regions where these little independent but ephemeral worlds naturally come into existence in the greatest number, for in falling such a distance from the remote confines of the system, matter has had time in greater proportion to accumulate into collections of planetoidal magnitude. When raised to this condition, the sun, of course, loses them for ever, for there is not a fact in the range of science admits of more conclusive proof than that when matter once attains independence under a sun, after the first round on its orbit, it no longer gravitates, and if it is not in a position to be permanent it succumbs, not to the sun, which it never can do, but to a secondary body larger than itself. As regards the earth—and with it we include what we designate, rightly or wrongly, the three other habitable worlds in the system, Mars, Venus, and Mercury—it has, we suppose, unlike the major planets, been made up almost wholly from matter in the atomic state up to aerolites, or in other words gravitating matter, the reasons for which may be thus accounted for.

It is, in the first place, according to nature that planetoids would continue to thicken in their approach nearer the sun, but this is only applicable to the system taken in broad divisions. In a position, for instance, so near the sun as that of the earth, the gravitation of the falling aerolites must become accelerated in rapidity, and their descending motion be even greatly in excess of his increased attraction upon them. In short, the meteoric swiftness of an aerolite in our atmosphere may be an indication of the velocity of gravitation in the latitude of the earth; so that it is almost impossible, for want of time and many other reasons, for these small gravitating collections of matter to combine into planetoids and thus attain magnitudes—where the opposing force of the sun is so much stronger—that would be centres of gravity. Thus we may consider that the earth since the beginning, but more especially in later time, as a body has been made up from a few drops out of the great shower of aerolites that have been from all points of the system during that time concentrating to the sun. Our everyday experience clearly demonstrates these facts, but the earth is partly made up from planetoids notwithstanding. It was, in the first instance, a mere invisible atom, far remote from where it is, and, like all other atoms, commenced its descent to the sun by the force of his attraction, increasing, however, in its career to an aerolite; and finally, through its revolving motion, it combined with other aerolites into a planetoid, and in that position it at once took up its permanent relation to the sun. All these things must have taken place, or else our globe could have had no existence, for such was the beginning of all secondary bodies. In its first step of independence it began as a planetoid, and no doubt many other planetoids came into it, being at or near the same latitude and within reach of its grasp. These added a certain proportion to its bulk, the first nucleus of the magnitude it gradually attained in the ages that followed down to the present.

Aerolites, likewise, continually fall upon the earth of all sizes. They never reach the surface solid and unbroken, but break up by explosion, and descend in showers of atoms, for the most part invisible, continued for miles, coinciding with the course the aerolite takes while visible. This rule applies not only to aerolites, but likewise to planetoids, and it may be their compounds as little worlds becoming incorporated with big ones, but only so when the collided bodies are blessed with atmospheres, one of the wonderful provisions of Almighty Wisdom for the safety of the living. He continues enlarging His created worlds by the imperceptible union of new matter without inflicting injury or producing disfigurement. Of course, when a colliding body is too large, it cannot have its materials scattered broadcast over an atmosphere in an invisible state, but even in connection with the incorporation of the largest colliding bodies —events in the present settled condition of the system that may be said never happen—the same observations are applicable. A body falling upon another, whatever may be its relative size, if it is only sufficiently small to have gravitation at or before coming into contact, must strike with the whole of its materials loose and unconnected. And when the difference in the two bodies is very wide, such, for instance, as a small asteroid, say a mile in diameter, there being no rock formation in such bodies for want of sufficient pressure, its collision, or rather incorporation, with a planet would be grand in the extreme. The result would not be very disastrous, even if there were inhabitants, and judging in an enlarged sense the operations of nature, it is not impossible but that a body of that size might be so related to the earth as eventually to become incorporated with it. Should such an event take place it would herald its approach by awful explosions along the full length of its fiery course; its invisible matter, getting scattered to the winds, would descend over a wide tract of country, and produce little change except a few fatalities that might be caused by the shower of meteoric stones that would descend.

The collision of formations so large, at least outside the asteroidal zone, in the present settled condition of the system, seldom or never occur, simply because planetoids have no time to become so enlarged before they are caught by one or other of the primaries. Earlier in creation, events of the kind and on a grander scale were frequent, and if in this age they happened in connection with any of the planets which have atmospheres, the results would be somewhat the same, greater or less according to the bulk of the incorporated bodies. In fact, the little asteroid—and the principle is applicable to the largest worlds—is but an aerolite of enormous growth, many of which we constantly see in the darkness of the night becoming incorporated with the earth. They illustrate to perfection, in the lowest scale, the nature of incorporation with planets according to the magnitude of the incorporated bodies. Both the higher and lower bodies are of recent creation, but the asteroid—not the little planets, the latest fruits of discovery—the oldest of the two, being by its magnitude a centre of gravity, is endowed with all the attributes of a world for its self-preservation against the sun, while the aerolite, by reason of its smallness, is without an attractive centre, and its fate is either to fall into the sun or upon a planet. It is simply a collection of atoms, as it were the creation of yesterday, fortuitously brought by the agency of revolving motion together, but without a common centre of attraction, and for the want of this protecting safeguard, attraction turning inwards to its centre—a principle, like all the laws of nature, simple in itself, but it is the basis upon which the safety of creation rests—it is soon lost in a vapour on whatever larger body it may fall, according to its allotted destination. In short, while it is an aerolite, there is not an atom within it but is acted upon by an attraction from without stronger than that inherent in itself as a body—if the term is applicable to a collection of shadowy atoms without a bond, which they cannot have except attraction turns them inward to their centre. This the aerolite has not, so that cohesion natural to itself is impossible, and all its parts, although remaining together, are, scientifically speaking, as much decentralised as if they were still in their primal state thousands of miles apart. Still its atoms keep together and continue so to do until it descends either on the sun or one of the planets. Revolving motion gradually brought all its atoms together, and in its gravitating course, while it has no power in itself to hold them in, neither are there any possible forces to scatter them abroad, for in its motion—all matter under the sun, be it atoms or worlds, revolve—in vacant space it can meet with no opposition. The aerolite, however, is subject to another kind of force—the attraction of the sun—but as this force acts equally upon all the parts, they must gravitate together under an equal pulling force. In a word, all the atoms of an aerolite, through the operations described, are by revolving motion brought together, but being too small as a collection of matter, it is without any internal bond to hold them in. When, however, once together, they encounter nothing that can separate them, and thus in a sense the whole of its atoms keep free from disintegration, until finally, after gravitating perhaps for years, it falls into the body attracting it most strongly, and, like a drop in the ocean, adds so much to the body it lights upon. Such, we suppose, is the true condition of all aerolites, or rather embryo worlds, which flow from every point of the system towards the sun by the force of his attraction. As this stream thickens the nearer the centre is approached, the earth is in a better position to benefit by a closer sprinkling of the descending drops than if its position were more remote, and it is from this source that its principal bulk has been made up from the time it began as a planetoid, but more especially in later times.

However, the due proportion of matter which the earth receives depends on the expanse of its attractive sphere—a principle applying equally to planetoids and gravitating matter, the latter of which only for the present concerns us. We call it a sphere of attraction, because it is a spherical space nearly equidistant from the earth in every direction of a minimum diameter, as we know by the lunar orbit, of half a million miles, and most likely considerably wider, within which its attraction acts stronger than that of the sun. The aerolites, therefore, which are for ever coming from all points to the sun, that hit upon this circular space ruled over by the earth, are at once within its power, out of whose grasp the sun cannot draw them. It is from these formations the earth is principally made up.

What proportion the earth receives of atomic and aerolitic matter compared to the sun could be very closely calculated if we knew the exact diameter of its attractive sphere, by which is intercepted a very small proportion of the falling matter for the benefit of the earth, according to the breadth it takes up. Suppose it to be half a million miles—and the lunar orbit proves that it can be no less—and comparing it with the total surface of the sphere of space at that distance from the sun, we find the result to be that even at this, the lowest measurement of the earth's sphere of rule, it is receiving a considerably larger proportion of new created matter as regards its magnitude than the sun, without including planetoidal bodies which are liable to fall into it in common with the other planets, none of which the sun can receive. Again, if we take the earth's sphere of attraction, at somewhat near its true expanse, which, everything considered, may range somewhere betwixt 600,000 and 800,000 miles, it will be found that it is actually receiving of atomic and aerolitic matter alone in proportion to its magnitude excessively above that of the sun. In the next place, if we turn to the other planets in their relation to the sun, we obtain reasonable data for concluding that they all receive a greater portion of gravitating matter than their mighty parent in the centre. Roughly speaking, the sun is as 500 to 1 compared with the other planets taken in the aggregate; but examining the great machine in all its parts we cannot help thinking—although without any reliable data to go upon—that, like the earth, the latter are receiving a much greater share than a five-hundredth part.

To take a broader view of the share of gravitating matter which falls to the sun, we are to look to the two great hemispheres of the system in which no planets exist. The rotation of the sun has inclined them to nearly the same plane, hence there are no attractive spheres to intercept the fall of matter into the sun over these vast regions. The only part which make up the total sphere of space, over which the attraction of the planets partially prevail, is that belt on which they all in common revolve, and the proportion of gravitating matter or rather aerolites they lay hold of must be according to the expanses of their attractive spheres; but being ignorant of the true measurement of their intercepting powers, it is impossible to tell the due proportion of gravitating matter each receives. Yet, if we take in the whole sphere of the heavens as far as the sun holds sway, making a very moderate estimate of the attractive spheres of the planets in their positions, we arrive at the conclusion that collectively they lay hold of and intercept much more than a five-hundredth part of the shower of matter that is for ever descending to the sun. Then, if we take into account the great proportion raised to planetoids—in reality overgrown aerolites—a class of bodies which we suppose add more to the primary planets, taking the system as a whole, than they receive from all other sources, with such facts before us, we cannot but come to the conclusion that altogether they are now receiving vastly more—we might venture to say a tenfold greater proportion, according to their magnitude—than what is falling to the share of the sun. Even on that scale all comes into him except a fiftieth part. If we are right, it follows that the planets are, and have been from the first, gaining upon the sun, but perhaps not in equal degree, for we suppose the four minor planets—those nearest the sun—gain in comparison in no greater ratio than intimated above in regard to the earth, and as to the three nearest of the four major planets, their gain upon the great parent centre may be in a far higher ratio. These bodies monopolise the region wherein planetoids in prepondering number obtain existence, and there they continue to revolve until they are caught by one or other, descending upon them in the self-same manner as aerolites on the earth, and that not on a much larger scale, for in those lattitudes the attraction of the sun is weaker, and planetoids in the same degree smaller. These wonderful bodies, were it not for aerolites rising up to the status of planetoids in such number on or near the belts of space their attractive spheres pass round, and thus enlarging them in an enormous degree, we venture to think even until now, although far larger than the earth, would not, we suppose, greatly exceed habitable size. Their overgrown proportions are chiefly owing to their position in the middle distance of an abnormally wide system, wherein nature stops matter in its largest collections gravitating to the sun, all of which is eventually incorporated into them. By so much as they are thus enlarged they gain in comparative magnitude to the sun and to the minor planets.

All newly created matter within the limits of the system comes into the sun, except what is intercepted by the attractive spheres of the planets in the manner described, and what in its descent rises to the status of planetoids. The question then naturally arises, How is it to be accounted for? The only reply we can give with any satisfaction, we cannot fully enter into for the present. We may, however, briefly remark, that at first it was possible that for millions of years matter continued to generate over what is now the system, diluted it may be somewhat equally throughout, and that without any material causes arising during that long atomic period to collect it into worlds. In this ethereal state, matter, for all that time, became more and more dense through uninterrupted creative increase until at last, space becoming surcharged, it so chanced that at some particular point rotatory motion was originated by atoms condensing into a particle, which thus became, however small, the first centre of attraction, and the nucleus of the sun. The surrounding atoms then fell into it, and, as it increased its influence, spread wider, drawing in invisible atoms, hitherto in a state of inertia, from circles still wider and wider until the existing limits of the system were reached. During the time this supposed momentous change in the formation of the sun was taking place, he was turning as now on an axis—this motion having begun when no larger than a grain of dust—so that the atoms of creation, hitherto a galaxy, in being attracted were also made to revolve. They were thus led into one another, and increased in magnitude in their gravitating course to the centre, till at last when the mist of ages was cleared away, nearly the whole had concentrated into the great body in the centre, nothing being left behind but millions of planetoids.

By the mighty power of his rotatory motion, the sun at once set the planetoids all revolving, and by these movements they, for the most part, were soon inclined up to the same plane which the existing planets hold. As already observed, they were millions in number—for they then must have been numerous, proportionate to the total quantity of matter previously in its milky state—nearly all as yet in this first step of planetary formation insignificant planetoids. In the same degree as they were numerous their orbits were thick and crowded, and of necessity intersecting at myriads of points. At these crossing points, their movements gradually led one upon another, the smaller becoming incorporated with the larger, until in time all that intersected were in succession lost one into the other, till at last not one was left, except the very few whose orbits are and will always continue to be free of each other—the eight primaries of the system. These primaries, no doubt, during the formation of the sun out of the ethereal matter of the galaxy, were all left behind on a level with the others as insignificant planetoids; but in the natural operations of revolving motion which was incorporating them, some among the millions were sure to take the lead in acquiring magnitude, and these eight, with their moons in a lower degree, were the favoured few into which all the others were eventually incorporated.

When all that was left behind at this first momentous step in the formation of the sun and the insignificant planetoidal formations, thus through their revolving motions were collected together into these eight solitary representatives, and their moons, however long since that may have been, the system was perfectly constituted, but the bodies within it were, as yet, even the largest of them, insignificant, and the sun, by comparison to his existing magnitude, was still small, but in relative magnitude far above what he is at present. We cannot, of course, tell what may then have been the comparison, but this we know, that he is at present at least five hundred to one, as compared to the combined magnitude of all the planets, and it would be no extravagant assertion to say that at the earliest time at which the constitution of the system became perfected, the difference may have been ten thousand to one. Yet the difference through the undue proportionate share of new creation which the planets received during the lapse of time has greatly lessened, and, so long as creation continues, smaller bodies—for the principle applies both to primary and secondary systems—will continue to gain something upon the larger which govern them.

The observations upon the first formation of the sun and system out of a galaxy, are not put forward as indisputable truths, for it is out of our power to base them on facts; but, nevertheless, it is incontestable that the bodies of the system are receiving, according to their magnitude, far above their due share of the matter constantly coming from creative hands for their increase, and such a first modelling of the system as we have fancied would naturally account for it. Let us, however, direct our attention more particularly to aerolites, the subject on hand.

An aerolite, in its descent to the sun, is intercepted by the terrestrial sphere of attraction, and is made by stronger attraction to turn towards us instead of continuing to the sun, into which his attraction was hitherto leading it. In descending upon the earth it has still a falling journey of at least a quarter-million of miles before its career is ended, during its descent both revolving round the earth and gravitating to it simultaneously. By the attraction of the earth it, of course, has a gravity from the first, or it would not descend, but the nearer it approaches the gravity increases, or in other words, it gets heavier, until at last it touches the atmosphere —its first point of collision. Coming so near, according to its bulk, it acquires considerable weight—not much less than if on the surface—and therefore an equal degree of force from its velocity of motion. But this of itself would have no effect in dispersing its atoms, and, if it met with no material opposition, it would descend whole to the surface without being scattered abroad. However, at an elevation of about forty miles it strikes the atmosphere, and by its velocity of motion the uncombined atomic materials of which it is made up are unresistingly brushed right and left until the whole are exhausted along its fiery track, left floating on the resisting medium along a distance equal to the length of its red train, and in this invisible state it settles down, in some cases over a considerable surface of country.

The aerolite in its descent to the earth—if we are to account for the important effect produced by the accession of such bodies

—must be looked upon as what it naturally is, a collection of matter brought into contact by revolving motion fresh from the Creator's hands, without being in the least degree consolidated, and free from any bond of union to hold its atoms together, the opposing atmosphere in this state easily scattering it into vapour, in which condition it settles down and adds so much to our globe. Such is the condition of the visible aerolites; but we suppose a great proportion of the matter which reaches us is so minute that it comes unperceived to the earth from without. The larger collections, as observed above, make themselves seen, some as short threads of fire, barely perceptible; but they become brighter in the ascending scale up to the lurid fiery train that stretches at a shot across half the heavens with splendid grandeur. We need hardly add that the aerolites are of a size proportionate to the meteors, and that the latter are fuller and more splendid according to the quantity of matter in the uncompressed body exploded, hence the larger the aerolite the longer is its track of fire, and the extent of country over which its scattered atoms descend is in the same degree wider. We say both larger and wider, for as the atoms are all nearly as heavy as the weight of matter upon the surface, they are thus by their colliding force on the atmosphere driven out widely in a lateral direction along its whole visible course, until its total matter is spread broadcast to the winds.

The cause of the atomic materials of the aerolite becoming reddened with heat is truly accounted for by their friction on the resisting medium through their velocity of motion. The instant they encounter the atmosphere their inconceivable rapidity through it as a material opposing force produces an intense red heat, which, in very small proportion, melts them into liquid. Accidentally the latter comes together in uncongealed lumps, which their rapid gravitation through the air in a soft melted state sharpens, so that they reach us as objects of a wedge-like shape and nearly uniform. These objects are termed meteoric stones, the only perceptible evidence of the matter that aerolites bestow upon the earth, but on the least reflection it must strike the mind of the student that they form but an infinitesimal proportion of the aerolites which we receive, and we think it is only the larger ones from which these meteoric stones proceed.

What may be the real size of the aerolites, judging their magnitudes by their appearances, no man can tell; or what might be the total quantity of matter—from invisible atoms to aerolites, and in extremely rare occasions planetoids—which is slowly making our world grow larger as well as the other bodies of the system, is a hopeless task even to surmise; but if we could only be let into the secret on the assumption as to given time an equal quantity of matter has originated during the past, the age of creation could be measured, and the millions of years—we are almost tempted to say hundreds of millions—that have passed since the primal atoms which were the nuclei of all created bodies first floated over the dark abyss. When creation will end and the worlds cease to grow, is another dark mystery. The time was when, in this visible portion of space, there was no matter, and the blackest darkness prevailed, but it pleased the Mighty One that worlds fit for habitation should come into existence, in time to become nurseries for the increase of immortal beings, and, at the fiat of His will, matter began, by some natural law beyond human comprehension, to originate, and from imperceptible atoms it has, by something like the operations described, moulded itself into suns first and worlds afterwards; and these have been continually added to by the increase of matter from that time to the present, until at last they are enlarged to the glorious galaxy of lights which adorn the universe. The operations going on and their workings revealed to us prove, as clearly as if we had existed through all the ages as eye-witnesses, that all these mighty wonders had a beginning, also that they continue in their fullest vigour, and that they must at some time or other come to an end, for there is no sounder axiom in philosophy than that whatever has had a beginning must have an ending.

From the description given of the dissolution of an aerolite when it collides on the atmosphere, and its final incorporation with the earth—the phenomena being precisely the same, only on a larger scale in the rare instances in which planetoids descend upon the earth—it follows that some of these latter have come down to us, and have been recorded as historical facts under the name of aerolites. In thus viewing the question we must bear in mind that the only difference between the aerolite and planetoid is, that the latter has a bulk of matter large enough to bestow upon it an attractive centre, and that the other has not, and that both are the beginnings of worlds, having, of course, their materials collected together by the same operations.

The planetoid has an attractive centre, wherever it may be, and while it retains its central life the action of no other matter can impose gravitation upon it. During its existence, therefore, it revolves round the sun on an orbit the same as any other independent body. The time which such small bodies exist is, in the average of cases, prolonged equally to that which possibly elapsed in the subjugation of lunar bodies to planets, as described under another head in the formation of secondary systems. No doubt, in one sense, we are here dealing with imaginary bodies, but so sure as there are aerolites, planetoids must exist in the next step of the ascending scale, and that too in thousands, throughout the system. It is, therefore, but reasonable to suppose that as nature is constantly forming them, although they are and must be invisible, some of them are winding round the sun on, or nearly on, terrestrial latitude, and from time to time—perhaps once or twice in a century—they may be caught within our attractive sphere and thus be incorporated with the earth.

The size of a planetoid in our latitude—for it must be remembered that this lowest class of independent bodies decrease in magnitude as the distance from the sun increases—is the principle to be considered, and the necessary bulk of matter to raise it to this status is what we cannot determine. The imaginary body B, however, in the opening chapter, we think, everything considered, comes nearest to the requisite magnitude, hence, although we have nothing definite to go upon, our idea of the lowest possible size of a planetoid at this distance from the sun would be a ball—if planetoids took such a shape, which they do not—having a surface measurement of several acres, perhaps a mile, half a mile, or even less in diameter. Now, many of these insignificant bodies, or rather overgrown aerolites, may be rolling round the sun on orbits more or less eccentric—and as a general rule the orbits of all the small bodies already traced are more eccentric than those of the planets—which, at points, may cut the orbits of the earth and Venus on the one hand, or Mars and the earth on the other; or the orbital course of a planetoid may pass over the whole three. As a class of small bodies they are, therefore, liable to be laid hold of by more than one planet; and whenever they are caught within the attractive spheres of one or other of these, or indeed any body, they are, of course, charmed in, we know not how, and incorporated with the particular planet that first seizes them, and collide on it, precisely similar to aerolites, only on a larger scale and with grander results.

As the fall of planetoids on the earth produces the same effects as aerolites, according to their magnitude, it would be presumption to conclude, however likely it may be, that the largest aerolites on record have been actual planetoids, it being impossible to ascertain what may have been the magnitude of these greatest known meteoric bodies, as so large a proportion of them comes to us in an invisible condition. That they have descended upon the earth, and that they will come down upon it, are facts undeniable. The presence of our moon is one proof of it, and the existence of the earth itself is another, for like all worlds they increased from this low condition to their present magnitudes. The same operations which enabled them to rest at this distance from the sun, as planetoids, still continue, and it is unquestionable that through the ages past, instead of being attracted into him as nearly all matter in the aerolitic condition must be, and in the future to come, many such planetoidal bodies have been and will be formed, also that the earth from these formations owes at least a fractional part of the matter that makes it up.

Let us give a fanciful description of one of these unseen bodies, some of which we imagine revolve in our latitude, and are in due time destined to form part of the earth. Is it a little globular world composed of rocks, water, and the other varieties of material that we see about us? Certainly not; for the operations which have thus far formed it could have produced no such shape, and there are most likely neither rocks nor particles in its composition, nor a drop of water, as it is without atmosphere

quefy its aqueous matter. Enormous pressure is supposed
be one thing necessary to consolidate matter into hard rock,
the materials of the planetoid are free from anything like
pressure which would so act upon it. True, it is large
ugh to be a centre of gravity, and therefore so far an in-
endent body; but the balance of attraction centreward as
posed to the sun is so barely turned that the force whereby its
terials incline inward is so infinitesimal that, if it were possible
be buried in the heart of one of these insignificant bodies, the
gregate pressure of the total exterior matter would scarcely be
. In a word, the planetoid is a mimic world composed
olly of the imperceptible atoms of creation brought together by
olving motion, first as aerolites, and these latter recombining
ough the same operations become, in one case out of millions,
enlarged as to be by their inherent attraction strong enough,
d no more, to turn their materials inwards, and that with a
ssure so slight as not in the least degree to change its purely
atoms from their primal condition.

Another fancied characteristic of these recent creations is, that
y are of the purest white. This is the natural colour of all
tter, uncontaminated with the decay of life or dyed with other
des of colour by the influence of atmosphere. Referring to
earth for instance, its secondary rocks are not of pure creative
ite, simply because they are tinged with atmospheric rust; the
face also is everywhere polluted by the remains of life, but with
se exceptions our globe is by nature of spotless white, so em-
matic of its divine origin, although it may have assumed various
ours in its hard rocky condition. It is only, however, to the
ses that they wear false colours, for the rays of the sun, no less
ite by nature, resolve themselves into many colours by atmo-
eric action; and in like manner all the primary rocks have in
mselves by nature a snowy whiteness. The lump of granite,
atever may be its apparent colour, when ground into dust is of
purest white, and the block of basalt when reduced to the same
te, however grimy a black it may be when solid, comes out in
iteness of pristine purity. Even water itself is of creative white-
ss, for we frequently see it in its evaporated condition returning
us consolidated into flakes of snow.

The Creator from the beginning has thus sent us all matter in
primal state of snowy whiteness, first coming to us in its hea-
nly purity, however it may in the course of time be greatly
figured with corroding atmosphere, or polluted by the remains
the living. A country deeply covered with new-fallen snow,
th everything black concealed from view, just meets our ideas
creative purity, but its native beauty is soon blurred by the
nosphere. Planetoids and aerolites are not exposed to these
nditions, so that their materials probably continue in their pris-
e state of the purest white. They have no rocks or stones
thin them to assume darker shades, for, practically speaking,
eir materials are free from pressure. Their outside surfaces are

not dyed with atmosphere, for they have none, and decay and rottenness are foreign to them, as upon them there can be no life. As a whole, they may be described as the smallest independent bodies in the universe, but of snowy whiteness within and without, for they are free from exposure to those elements which might imprint new colours upon them. Taking planetoids separately, they are perfectly dry, for, while they undoubtedly contain their fair proportion of aqueous matter, there is no heat to liquify it. All their parts are made up of invisible atoms, also in their primal state, the pressure which could change them into a new condition being absent. Finally, planetoids are held together by bonds of inherent attraction, so feeble that if it were possible to oppose any of them to the force even of a gentle breeze they would vanish as invisible vapour.

To describe the union of a planetoid with the earth, it is necessary to give a description of the supposed manner of its approach, so that if any one of these to be dreaded visitors may reach us during our time, we shall know how to distinguish it. How the aerolite approaches is well known. It strikes our upper atmosphere, rushes through it with great velocity across the heavens, and for the full length of its fiery track gets dissolved into vapour, and is no more seen. We suppose its visible rate of motion is simply its velocity of gravitation to the sun, continued after being deflected earthward. To explain the idea more freely, we may look upon any aerolite as having commenced its fall perhaps two or three thousand million miles distant. Its gravitation to the sun at first, no doubt, is extremely slow, but as falling motion constantly accelerates, by the time it descends a few thousand million miles of space its velocity is so great that at such a rate it would soon reach the sun. Its course, however, is stopped in that direction by its having come within our attractive sphere, and the stronger attraction of the earth instantly laying hold of it diverts it to itself. The direction of the motion is turned by the change, but probably there is nothing in the operation to slacken the velocity, and it strikes our atmosphere with the same rapidity of descent as if its fall in the direction of the sun had not been intercepted. When a planetoid falls to the earth for want of the gravitating motion of the aerolite, it does not herald its approach with apparent lightning speed, but from its first appearance until it dissolves into nothingness, while it is actually gravitating down to the earth, it is apparently fixed. In short, the aerolite rushes sideways by the rapid gravitation it previously received from the sun, while the planetoid approaches its dissolution in a straight line with a rapidity we cannot describe, acquired by the unknown causes which lead all bodies when caught within secondary attractive spheres to be charmed in to their destroyers.

The planetoid before it is caught was, and may have been for thousands of years, revolving round the sun, like any other planet, on an orbit, no matter how eccentric, which at some point touched the track passed round by the attractive sphere of the earth.

When once its motion leads it so that the two come into conjunction with the sun, so near each other that the smaller is within the attractive sphere of the larger, its career is soon ended by being incorporated with it. Previously, under primary rule it was safe, for the sun can attract in no body which is a centre of gravity, but once within the grasp of secondary rule its separate individuality is at an end. The mysterious principle no man has yet accounted for, but still the fact is strongly written in the workings of the heavens, that all bodies, be they planetoids or worlds of a larger size—when once led by their motions under planetary control it is their universal fate, excepting in the rare cases in which the bodies are to be led in and incorporated with the planets which lay hold of them—are sufficiently large to become moons. All collections of matter, be they aerolites, planetoids, or larger bodies, when once led by their movements within the attractive spheres of the primaries, become incorporated; it is from this source they are made up—with the rare exceptions which have happened, one case out of millions, in descending to their inevitable fate some were large enough to be moons, and endowed with sufficiently slower axial motions compared to the same motions of the planets they were approaching. A planetoid, whatever may be its axial rate, is too small to be lunarised; its unavoidable fate is, therefore, incorporation, whether falling upon the earth or whatever planet may first captivate it.

The planetoid when it first touches our attractive sphere, the attractive forces of the sun and earth, as opposed to each other, are exactly equal upon it, but being, however short a distance, once inside the terrestrial attractive sphere, it is subject to a stronger attraction than previously under the sun. Still, we must look upon it as a centre of gravity, or rather at that distance the attraction of the earth is weaker upon its own materials than that inherent in itself as a body, so that they for so far cling to their own centre. This condition is the only protection wanted for its safety while in subjection to the sun, but once under secondary control, it descends earthward—we know not how—and thus its centre of attraction as under the sun is no longer a safeguard. It is within the precincts of secondary rule wherein bodies—moons excepted—are universally charmed into mutual incorporation on some unknown principle that awaits discovery. As it continues descending its attraction is still the same, but at every step nearer, that of the earth becomes stronger upon it, till at last, when its approach is sufficiently near, the attraction of the latter is stronger upon it than the same force inherent in itself. In that instant, the feeble bond—feeble in so small a body—becomes snapped, and its materials loosened with no more natural cohesion left than if they were scattered wide over the expanse, and, plunging into the atmosphere in this state, its opposing force is strong enough to widely spread the whole into their pristine vapoury condition, which gradually and imperceptibly settles down, and by so much adds to the bulk of the earth.

When a body loses its attractive centre, as above described, there is a popular error that, being thus dissolved, its materials would spread like clouds of mist into their primal atomic state; but this cannot be without a scattering force is applied. As yet the force is not present, for in its revolving course under the rotation of the earth the planetoid meets with no opposition, and, as a gravitating body, which it now is, the attraction is equal upon the whole of its materials, so that they must all descend at the same rate. Hence, by the simple loss of its centre of gravity, while all the atoms are loose and uncombined, there can as yet be no wide separation between them. It is on the same principle that the congeries of atoms which compose an aerolite keeps together perhaps for years; while the planetoid by its nearness to the earth, thus reduced to the condition of an aerolite, cannot spread for so far in its descent. It soon, however, encounters the atmosphere as an opposing force, which instantly permeates all its parts, causing it at a hundred points to burst asunder with awful exploding noises. Thus it spreads out in cloudy vapour far and wide all the atomic materials of its body—still retaining their primal condition unchanged by pressure or any other cause—except the infinitesimal portion melted by the electric fire, and which descends in a shower of meteoric stones over perhaps a radius of fifty miles of country.

What becomes of the rest of the planetoid—the stones as compared to the whole are as nothing—and where does the bulk go to? We may find our reply if we look upon the planetoid as wholly composed of matter in its purely atomic state, and without having undergone any change from the condition it was first in as an ethereal fluid, except that its atomic materials having been condensed by revolving motion into a body so small as to be practically without pressive force on its materials; beaten upon by no atmosphere, without a drop of liquid or a sign of dampness or moisture, it is impossible that the atoms could have undergone any change, although they may have previously been feebly held together as a quasi-independent body for long ages. Coming on our atmosphere with its matter in this condition, the forces it encounters are just those which would spread out the whole into a natural vapoury state, and which would settle down very slowly, unobserved and perhaps imperceptible, after being wafted by the winds hither and thither over a wide tract of country. The locality over which it explodes has the full benefit of the meteoric stones, while the remainder in great part is carried, as we have said, over a much wider area.

The planetoid and aerolite, except in magnitude and manner of approach, may be considered in their materials and dissolution to be much the same. The aerolite suddenly shoots across the heavens, and its materials by the instantaneous operation vanish into invisibility, with the exception of the stones the larger aerolites discharge. On the other hand, the planetoids upon the very few occasions they have bestowed magnitude upon the earth—

probably not more on the average than two or three times in a century—have had their bodies dissolved into apparent nihility, much the same, but their approach is more modest and dignified. Taking any planetoid singly it shoots not with a livid glare across the heavens, but, at least in the last part of its approach, probably for about a fifth of a million of miles—more or less, according to its size—in a direct line, owing to the gravitation imposed upon it by the attraction of the earth. If we only knew of the arrival of such a visitor, and were to look out for it, possibly we should see it on a clear day, before touching the atmosphere, as a white speck apparently without motion. As it came nearer, and when it touched the atmosphere, we should hear it exploding with peals louder than thunder during the few moments its materials were being swept into invisibility by the opposing atmosphere, and it would no more be seen. These phenomena could all be witnessed dimly even in the presence of the sun, but how much grander the sight would be by night! The first we should know of it would be by seeing a huge meteoric body, not darting across the sky, but on account of its line of approach appearing to be stationary, enveloped in a glare of fire, and, bursting with loud explosions, vanish right and left into invisibility in an incredibly short space of time, leaving nothing to tell of its presence excepting the thick shower of stones which it would sprinkle over the locality, in some instances no doubt attended with fatal effects. Such, according to our ideas, are the results attending the incorporation of a planetoid. The description is not from fancy, but actual fact, as such an event was upon one occasion witnessed.

We have already tried to account for the meteoric stones by the intense heat instantaneously raised turning into melted liquid a small portion of the material, but we suppose they are not common to all aerolites. At least none of them have ever been known to come down from the smallest meteors; an occasional one falls from aerolites respectably large, and from the largest, two, three, and even more have been known to descend, while from falling planetoids, events so rare as to be landmarks in history, we suppose they literally descend in hundreds, all from the same cause in both classes of bodies, the melting of a small moiety of their materials.

As before observed, the atoms of the aerolite or planetoid becoming melted fall together into lumps of liquid, and thus descend in showers of what is very properly termed meteoric stones. The descent of these stones is through a space perhaps not far short of twenty miles, yet even after that tedious fall those of a respectable size if examined immediately they fall are always found to be hot. Their burning heat when they come down is, therefore, clear evidence of their origin, but the clearest proof is their similarity of form, smoothed sides and rounded edges, just the shape that liquid rock—matter in its primal atomic state is in reality rock, but not reduced by change to such a solid condition

—during its congealment would assume in its rapid descent by the friction of the air. These stones only descend as odd drops out of the total matter of the bodies, whether aerolites or planetoids, for, as time after time observed, the whole of the body is a congeries of uncompressed creative atoms which by the explosion become scattered as vapour over a considerable tract of country, if an aerolite along the full length of its visible passage through the air, and the presence of the vapour might betoken a murky sky, yet the atoms descend upon the surface as imperceptibly as the morning dew. The earth, together with the sun and planets, from these causes, grow silently and unperceived, and as all the matter comes from the same source—the shower for ever descending to the sun, the latter receiving nearly the whole, the others intercepting the drops, according to the expansions of their attractive spheres and the positions they hold—it follows that if they are thus made up it must be of the same identical kind of materials. They each, therefore, have the same proportion of water, metals, and every other kind of known materials, and the idea is not irrational that every invisible created atom contains within itself a due proportion of all the varieties of material which belong to the earth as a whole.

The number of bodies or objects—the visible ones termed aerolites—of matter which fall upon the earth in a single year must be enormous, for they descend with the same frequency both by day and night, and equally over all parts of its surface, and they have continued to do so from the earliest times on record in about the same proportion, we might almost venture to say in hundreds of millions yearly, if it were possible to enumerate them. It might, therefore, be possible that some of the largest meteors on record may have been actual planetoids, not to mention a greater number that may have come upon the earth out of the view of civilisation. A vast proportion, from the atom upwards, comes unseen, but when of a certain size they show as white threads of fire, barely perceptible, up to bodies which during the moments of their dissolution leave behind them trains of fire sublimely grand, bursting into a vapour state with the voice of thunder. When all is over, the only portion of their matter left visible are the melted atoms that get congealed from the liquid state and come down to us as meteorites.

Some of these awful visitors have, at rare intervals, fallen upon the earth, and as the manner of their approach has not generally been recorded, the question naturally arises, were they planetoids, or rather sister planets of our globe, which have been revolving round the sun at about the same mean distance for at least thousands of years, and are at last laid hold of to become terrestrial material, or were they some of the largest aerolites which are constantly concentrating towards the sun? One fact, as repeatedly stated, is certain, namely, that the earth is made up—although in small part—as well as the other minor planets, by planetoids, and perhaps in rare instances by larger bodies. We might refer to some of the accounts of great meteors, handed down to us by the ancients, much more wonderful than any recorded in recent times, but as they would be treated as apocryphal we will confine ourselves to the description of two of the latest of these visitors.

Near the close of last century a great aerolite exploded over the district of Benares, in India, and was witnessed both by natives and Europeans. It showed itself as a ball of fire, and during the moments of its dissolution it continued bursting with exploding noises, illuminating the atmosphere with electric brightness, and sending down showers of stones over a considerable tract of country. A few years later a similar phenomenon occurred in one of the French departments, but it took place in broad day, so that it lacked the grand appearance of the other; but the results were equally great. The meteor, although exposed to the glare of day, was distinctly visible, in size like a small fixed cloud, and the exploding noises were terrible, from which showers of stones descended over more than a hundred miles of country. The meteor at Benares we cannot classify, for the manner of its approach is not stated; but the record of the French meteor fortunately mentions that it appeared to be immovable, and therefore it must have been a planetoid, if such bodies are to be distinguished by their direction of approach.

We might detail other grand instances of the kind, both ancient and modern, and reasonably conclude that a much greater number may have fallen over different parts of the globe out of the view of civilised men, but whether such formidable visitors have been real planetoids we must leave others to determine. It is only a true knowledge of the magnitude of such grand meteoric bodies that would settle the question; but such discoveries in the existing condition of science are impossible. If we are to judge of their magnitude by the total meteoric stones that even the largest of them send down, if all were collected together, they would form but a miserable proportion of a body large enough to be a planetoid, but, if the description we have given of these formations is anything like correct, the stones which descend are not a millionth part of the meteoric bodies from whence they descend. Even after allowing such a wide margin—but we think it much too narrow—whether or not some of these historic visitors, previous to their dissolution, were of planetoidal magnitude is the question. Granting, however, that the largest of them, previous to incorporation, were planetoids, they were only odd ones out of the many which, in our latitude, are revolving round the sun, and which have continued to do so, perhaps, for thousands of years. They one after the other continue to be caught within our attractive sphere, and incorporated with the earth. Nature still continues to generate matter which, revolving motion ever at work, collects into new formations to supply the place of those that are being constantly led by their motions into either the sun or planets. The supply is held up and the worlds grow bigger.

If there had been no revolving motion, planetoids could never be formed, but the rotation of the sun makes this motion universal; all revolve, from the minutest atom to the largest planet. If he as a body had been without rotation, there would have been no revolving motion within his precincts, the atoms of creation as they continued to originate, instead of in their solar descent revolving sideways, and thus coming upon and uniting together, would have fallen to the sun in their primal condition in straight lines, and from the beginning until now the whole of created matter subject to his attraction would have concentrated into him in its unchanged fluid or ethereal state. There would then only be one created centre in our midst. No atoms could have joined atoms, no aerolites could have mutually combined, consequently there would have been no planetoids, no asteroids, no worlds to live on, but simply a solitude, and that with a glorious luminary in the centre, sending out useless brilliancy into surrounding space. By the sun's simple motion upon an axis—how sublimely beautiful is the working of Almighty Wisdom!—creation is not in vain, an array of habitable worlds are given, and in more than one of them beings enjoy the happiness of terrestrial life.

Let us view the operations more minutely. The key of the position lies in the unfathomable design of Omnipotence in ordaining natural laws which bestowed upon the sun, and we think all other bodies, axial motion. His attraction, to a certain distance, prevails over that of any other sun, forming what may be termed his dominion. Certain natural operations are going on, we suppose, equally throughout this expanse, by which matter generates, or rather originates, in what we imagine an atomic state, and at first as imperceptible as the aqueous atoms evaporated into a clear sky. How this matter comes into being, apparently out of nothing, is, like many other secrets of nature, beyond human comprehension; but that it is constantly reproducing itself is a fact proved beyond all doubt by the matter which we constantly see coming in and at an exceedingly slow rate, swelling out the worlds to greater magnitude. It is doing so to the earth, and unquestionably the operations are universal. When these atoms first exist in their countless millions—they are of such a nature that that number could be contained within the smallest measure—they are governed by the rotation of the sun, in all respects as the largest bodies; in fact, each atom is the beginning of a world, if all the circumstances could be favourable for its development into such, going round the sun at the same rate, according to distance, as any of the planets, but with this difference, that it both revolves round and gravitates to the sun. The millions of other atoms do the same, simultaneously, all in one direction, harmoniously with the rotation of the sun which produces these motions from west to east, thus constantly causing them to come into each other. It is by these motions that they come into contact one with the other and accumulate into aerolites, which, by the same motions in turn combine together, and notwithstanding—if not too much enlarged—still continue in their course towards the sun, and are thus constantly adding by countless millions to the bulk of the great parent. Perhaps in one case out of hundreds of millions, an aerolite becomes so enlarged as to be a centre of gravity, however limited, in itself, and, no matter how feebly, every atom in its composition turns to and clings in the direction of that centre ; the attraction of the body of which they all in common form a part is the attraction that acts strongest upon them. None of its parts can gravitate to the sun, nor can it do so as a whole, for it is surrounded by its sphere of attraction, narrow though it may be, and, being totally without weight while under primary government, it is impossible for it to fall in any direction. We need scarcely observe that the body thus far constituted is but a lowly planetoid. If it had reached this status among the primal formations, when the sun was first being formed, it then would have had a remote chance of being the nucleus of a planet. In these days, although such little worlds are constantly being formed, it is one of their characteristics, no matter in what latitude they may be, that they move on orbits very elliptical ; and, if they do not cross planetary orbits, they are all, at one time or other, so related as to touch upon some point of the belts of space their spheres of attraction pass round, and so perish in their embraces. For these reasons no new worlds in the present matured state of the system can be permanent, and wherever they may be, or what may be their number, they come into existence only eventually to add so many increments to one or other of the eight primaries in the different latitudes of the system.

CHAPTER XI.

TELESCOPIC STARS.

HAVING submitted our ideas as to what may be the extent of our system, the order and nature of the known and unknown bodies within it, with some remarks on the supposed natural operations which attended their formation, we are the better prepared to launch out in imagination among the stars into the great unknown. We may well say unknown, for with our boasted knowledge in astronomy, excepting the planetary motions of the double stars, all that we yet know outside our system is that there is an innumerable host of suns, and reasoning on the soundest analogy, we are enabled to conclude that nearly all these millions of suns rule separately over their subject systems. Our ignorance, otherwise, is so great that no man has yet been enabled to tell the distance of a single one of these suns, or even to form a vague notion of what may be their magnitude, further than that our sun being one of them, it is supposed they may be of average size.

If astronomers have not yet fathomed the distance of the stars, they, however, unanimously conclude that their remoteness is immensurable—so remote, in fact, that they find it impossible to reach the distance, the only base they can get for their triangle being too short to calculate from. Their base is the diameter of the earth's orbit, yet in all the attempts they have ever made on a line so long no observable angle has hitherto been subtended, hence the distance of the nearest stars is put down to be so immensely remote as to be out of the reach of science to discover. Numberless attempts have been made for the purpose, and they have ended in failures; but it may be they trusted to the evidence of the senses, and in their noble efforts to fathom the distance they have only experimented on the largest stars, judging them from their appearance to be the nearest. In no instances that we read of have they systematically tried to ascertain the distance or distances of those faint glimmering specks, the telescopic stars.

If, then, astronomers have committed the error of confining their observations to the brighter stars, we may well say that this is another instance of the deception of the evidence of the senses—the greatest enemy in all the past to the advancement of astronomical knowledge. For ages this deception led the wise men of antiquity to conclude the earth to be an interminable plain, and the centre of the universe. It is the same evidence which has led the whole of mankind, learned and unlearned, to pronounce the light and heat which habitable worlds enjoy as derived from balls of fire, and possibly it is the same cause which has led them to take for granted that the largest stars are the nearest suns. At all events, to this class alone they have directed their observations; but it is possible that these mighty luminaries are the most distant objects revealed either to the eye or the telescope.

According to their reasoning, which is, of course, based on their many fruitless attempts to fathom space to the stars, there is the long weary interval of no less than 20,000,000,000,000 miles, besides an unknown greater distance, at which they must be before the nearest of them can be reached. This conclusion, at least in part, rests on the unphilosophic idea that over that mighty extent a yawning void without a trace of creation exists—an expanse so inconceivably wide that if we were only placed midway, and could look back upon the sun and his system, supposing the whole expanse a sheet silvered over with borrowed light, it would be reduced in view almost to the insignificance of a telescopic speck. To our finite ideas the solar system is of mighty extent; but there is as much difference between it and the area it is supposed to occupy as there is between a planetoid and the sun. Are we to pronounce this supposed solitude a waste, and to conclude that because it is not yet discovered there is not a world to lighten its darkness. For what we yet know, such a conclusion is about as logical as that the limits of creation end at the horizon, or that there are no more worlds than those which are visible. On the contrary, we take it, for reasons which we shall state, that inside the stars which appear to the naked eye there are millions of worlds fairly distributed throughout, commencing not very far from the remotest precincts of our system, and it is to the discovery of some of these sunlets or unknown bodies, if they do exist, that the eyes of science should be turned.

It need hardly be mentioned that astronomers in trying to find the distance of a star take with the nicest accuracy the angle of its relation with some other celestial body, with a base for their hoped-for triangle of 190,000,000 miles. At the end of six months, if they cannot find an appreciable difference in the subtending angle of the two bodies, there is no discovery made, except the mathematical certainty that the star they wish to find the distance of is remote beyond the reach of measurement even on the acutest possible parallax. However, in making these attempts, which have been very numerous and oft-repeated for the last two or three centuries, we fancy no scientific rule has been generally adopted, and that in nearly all instances the stars have been taken at random, and in general of the first magnitude—the Dog Star being an especial favourite. How many have thus been operated upon since the invention of the telescope it is out of our power to tell, for there has been no tabulated list preserved; but they have been so numerous that we may fairly conclude that the majority of suns that sparkle of a clear night —but more especially those of the brightest colour, whatever may be their apparent size—are so remote that it is beyond the power of science to discover their distance.

We cannot suggest a rule whereby astronomers would be enabled to find out the distance of the nearest suns without referring to the celebrated instrument in general use for the purpose — the telescope. Its powers are wonderful, for it magnifies objects thousands of millions of miles distant, but in a widely different degree. From these examples of its magnifying powers in space so remote, there is a popular error in the scientific mind that it will reveal the presence of bodies far into infinitude, but taking a proper view of the question, it is not impossible to trace out the limits of its power.

A body near at hand is greatly magnified, at a greater distance the magnifying power of the telescope is proportionately less, and as remoteness still farther increases, its power of enlargement becomes weaker and weaker, till we can well conceive of a distance where it would have no effect. At such a distance, whatever it may be, no unseen body can be revealed to view by its power, and those visible to the naked eye, if in no nearer proximity, could be in no way magnified. It is represented that none of the visible stars are the least magnified even by the most powerful telescopes, and if the rule applies without exception to all the stars, they must be in space beyond where its powers are of no avail. But among so many the rule may not hold universally good, and if it so happens that any of the number are the least magnified—and we know this applies to the binary stars—no matter how insignificant they may appear to the eye they are unquestionably the nearest; and there is little doubt their distance, by the usual mode of observation, might be roughly ascertained. On the other hand, if the telescope fails to magnify any one of the stars, we may then conclude that no matter what degree of remoteness they may be in, they are the most distant bodies that either appear to the eye or to the telescope; and that the nearest of them, if within mensurable distance, must be immensely remote. What, however, in this respect may be discovered in the future, no surer guide could be taken to reveal such discoveries than the magnifying power of the telescope. The more it enlarges, the body is in the same degree nearer. Nevertheless it might be possible that the distance of the nearest visible stars could be ascertained, although they may be in that remoteness of space where the telescope has no power, if they could only be hit upon. Strange as it may sound, we suppose as a general rule stars of the first magnitude are by no means the nearest, and the labours of scientific men would much more likely be rewarded if their observations were bestowed on those, whatever may be their insignificance, that shine with pale and subdued lights.

There is one class of suns that the telescope has a commanding power over, named after the instrument the telescopic stars, and it is upon this class that science should turn its eyes, if but a vague knowledge is to be attained of the outlines of our system and the firmament of little stars immediately beyond its borders. These glimmering specks are universally taken as being one and all beyond the bright stars, but the telescope tells a tale which proves such a position to be impossible. At or among the stars, or rather greatest suns of space, as before observed, the telescope, on account of the enormous distance, has no power to magnify, neither can it evolve from darkness into light bodies or suns which, according to the reasoning of some persons, must be thousands of times more remote—their remoteness being founded on the logical idea that as the bright stars are the nearest suns, each one of the millions magnified into view must be at least as wide apart from each other as the supposed nearest suns are to our system. A moment's reflection surely ought to strike such persons that at the distance some of them must be, beyond the power of the imagination to conceive, it would be impossible that a thousandth part of the number could be seen by the telescope, even after admitting the absurdity that the instrument has the power to magnify so far into infinitude.

We shall not go beyond the stars to find a place for the telescopic suns, and without an item of direct proof we take our stand on the broad principle that they all lie in nearer space. This opinion we base on the irrefragable testimony of the telescope; for we look upon its magnifying power over them as proving with almost mathematical certainty that they cannot be immensely remote. Such a presumptuous assertion in the face of all human investigation proving the reverse, may well nigh take the breath from the reader. Where is there possible room for the millions of suns and their systems that the telescope proves to exist inside the stars? might be the first question contemptuously asked. Well, the question is to the purpose, and it can only be replied to by having recourse to figures.

It would be as difficult to find out the real number of the telescopic stars as to count the grains of sand upon the shore. Men of moderate ideas consider they amount at least to millions, but one sanguine individual, by counting the minute grains of telescopic dust over one or two very small measurements, and dividing these latter into the entire sphere of the heavens, has calculated them to be no less than a hundred million. Now, any one who has ever studied the deep significancy of the word million and its units, will see that a hundred million must be an exaggeration. We will, however, base our calculations upon that number, and see whether there is room for the whole of these hundred million of telescopic suns, with their systems, in that expanse of space which is known to exist to the nearest stars, with our sun as a supposed solitary speck in the centre.

The width of the expanse is as yet an unknown quantity, but whatever it may be, countless observations made by the greatest mathematicians of modern times have proved it to be not less than 40,000,000,000,000 miles in diameter. This mighty abyss of space is put down, with the exception of our sun and system, as an empty void, but we are here trying to prove that all the telescopic suns lie within it. Allowing each one on an average with its system to be as large as our own, say 10,000,000,000 miles in diameter, and dividing the measurement before mentioned with these figures, we arrive at the astonishing answer that there is room for 64,000,000,000 systems as large as that of our sun. To put it otherwise, if there are a hundred million suns, each one on an average with a system as wide as our own, taken at ten thousand million miles in diameter, yet if their systems were all made to join, they would only take up a six-hundredth part of the space which all scientific men agree intervenes to the limits of the nearest stars, or what may be termed the great suns. What a contemptible proportion to the whole!—a six-hundredth part—so small that if it could only be viewed broadly by mortal eye, the room taken up with the telescopic solar systems would not sensibly diminish the vast area. The space is so wide that no array of figures nor the words of any language can convey a proper conception of its wonderful extent! Modern wisdom asserts the whole to be empty and without a vestige of creation, notwithstanding that the millions of telescopic suns with their systems would fill so small a portion of the whole as to be lost in the immensity. Such calculations should settle the question in regard to sufficient space being inside the stars for the telescopic suns, including their systems, without launching out to find a place for them in the unknown beyond the stars, where we think not one of them exists. Most likely there may be a kindred class of minor suns through the interstellar regions of all space dotted over by creation, but the telescope cannot reveal them. In space so remote its power is at an end.

Admitting the suns of the telescope to be in nearer proximity than the stars, we may ask, Do these glimmering sunlets thus revealed to view lie throughout the whole space? They are but creatures of the telescope, and are all included within the range of its magnifying power, so that it is not possible that a single one of them can be at a distance where that power cannot reach—no doubt an immense distance—but yet falling short of the remoteness of the great majority of the stars. Indeed, it is more likely than not that the greatest number of the telescopic stars may be in still closer proximity than the limits of telescopic power, whether as single bright specks, nebulæ—star clusters—or the many other curiosities which in those regions immediately exterior to our system have of late years been revealed. The idea of clusters of suns, that we are taught to look upon separately as star systems—the same in the positions they occupy as the hosts of suns we behold—being magnified into view at distances admitted to be, perhaps, ten thousand times more remote than any visible star, is preposterous, and to the common sense of reasonable beings their positions must be nearer. If so, they must be within the limits of the stars, and perhaps the majority in much nearer proximity.

If the telescopic suns are all in nearer space than the stars, they might be a rich field for discovery in the future. Human knowledge of the heavens is in a great measure confined to the comparatively small limits of our system, but in the telescopic stars we have suns and systems by the million, and the distance of a few might with some degree of accuracy be ascertained. Not one of them we read of has ever been operated upon as to its remoteness, and the true cause that they are overlooked is the universal undoubting belief that the stars are the nearest suns. Besides, to determine the distance of a star the observation must occupy a space of six months, and it probably has been the conclusion of philosophers—if the idea ever occurred to them—that it would be a waste of precious time to try to find the remoteness of a class of bodies they all believe to lie far beyond the stars.

The distance, therefore, of any of the telescopic stars is still unknown. We are yet in total ignorance of creation outside the system, except that attempted measurements have proved their inconceivable but unknown distance, and that by the clearest analogy we are enabled to infer that they are suns, having planets in subjection to them. In all other respects we still grope in foggy darkness for any further knowledge concerning them, with the few exceptions of the double stars and their planetary movements. If we are correct as to the locality of the telescopic stars, the motions of these double stars deserve to be ranked as the greatest astronomical discovery of the century—not for its intrinsic value *per se*, but as the initiatory step of discovery into what may be termed the telescopic regions. When these luminous planets were first found to revolve, if it had but occurred to the discoverer that revolving motion at so great a distance could not be detected, he might have thus conceived the happy idea of attempting to find their remoteness, and in the event of his efforts having been crowned with success, astronomers might by this time have been enabled to draw a map from several telescopic points outside our solar limits.

We do not absolutely deny that revolving motion could not be seen and calculated beyond the stars, but the bodies revolving, if visible even to the telescope, must be many times larger than our sun, and the suns round which they are proved to revolve of still greater magnitude. Not only so, but their supposed position far beyond the stars * is at such a distance, that a space of thousands of millions of miles across, if silvered over the whole extent with matter, could only be perceptible as a minute telescope point from the earth. Hence, if these double stars lie at that great distance they must be almost as far from the suns they roll round as from the earth to the stars, while their revolving motions, from the number of years they are known to move once round on their orbits, must be with a velocity of millions of miles every second. Now, any imaginary swiftness of orbital motion is possible, as its degree of velocity entirely depends on the rate of rotatory motion that it is under. By a stretch of imagination, therefore, we suppose that, in one solitary instance, beyond the stars all the above extraordinary conditions might meet, but we are dealing with planetary motion outside our system, not in one case but many; subject to such a combination of so many independent facts, it cannot be that all these binary stars have motions so inconceivably rapid. These bodies, or rather systems, must therefore be in positions nearer than the stars; some of them might be found a hundred, or perhaps a thousand times the distance of the remotest known part of the system, but however near or far they may be, it is probable that the positions of most, if not all of them, might be made known. Very few of the other telescopic stars, whatever may be their proximity, could be so easily observed, for they are so thickly crowded together that the task would be very difficult of holding constantly to the same minute speck; but the double stars could not be mistaken, and therefore they are fittest to be experimented upon, so as to set at rest the true position of the telescopic stars.

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* Some of the binary stars appear single to the naked eye, and, such being the case, they cannot be put down as beyond the stars, notwithstanding that they are included in the list of those supposed to be most remote.

If the telescopic stars lie in the comparatively near space we suppose, the question follows—How is it that they are insignificant as shining bodies, while the stars which we place far beyond sparkle with dazzling brilliancy both to the eye and to the telescope? The question may be partly answered by studying the effects produced by greater lights upon lesser ones; and the principle, in the first place, elucidated by the example of artificial lights as they act upon each other.

The flame of a candle spreads a feeble light over the whole room, but if a jet of gas sufficiently strong is placed so near it that its flame will cast a shadow, it gives out no light whatever. The light of the gas, even to the surface of the flame, replaces its light; and in reality it is a brighter light usurping the place of a paler. Should, however, the candle be removed a little farther from the jet of gas, it would spread out a light from itself, but only so far as the gas light is weaker than its own. In this latter position the candle, within a very limited area, would send out light, but if it were possible to extinguish the flame and its light to continue, the area lighted by it, being so very circumscribed, would be obliterated by the brighter gas light on all sides closely surrounding it, to such an extent that in the absence of a flame to mark the position, it would be impossible to distinguish it. Solar light is totally different from the nature of artificial light, or rather the light from fire, but the effects which the greater lights produce on the lesser correspond in every particular. The feebler lights of the universe are for the most part put out by the transcendent glory of the greater, but among the solar lights there is as great a difference as between the planets of the system as compared with each other in magnitude, and the greatest of the greater lights, if they cannot obliterate, obscure the more feeble into glimmering insignificance. The greatest lights within view are the stars, and it may be that the weaker lights are the millions of inferior suns which lie in the vast intervals between. The transcendent glory of the former so far eclipse the latter that the feebler lights of those revealed by the telescope, although they are much nearer, are entirely darkened from human vision.

There is no doubt that the telescopic suns are large bodies, although by comparison they are small, yet it is not by their magnitude that we see them or the stars beyond, but simply by their lights—a fact which may be made clear by having recourse once more to the example of artificial lights.

The flame of the candle is that which its light proceeds from, but at a very short distance the flame would not be seen, but the light itself would be visible a long way off. A brighter light would show at a still greater distance, quite irrespective of the size of the flame or fire it proceeds from. Take, for example, the electric light, the brightest of all artificial lights. It appears at the greatest distance—how far is perhaps unknown, for there are very few accessible elevations high enough for the experiment—perhaps above a hundred miles, whilst its flame, which would be about the size of a lighthouse flame, as an opaque substance—the term opaque being here used irrespective of colour—would become invisible at a ten-thousandth part of the distance. Solar light is still brighter, and just in proportion to its brightness, and the extent to which it is permitted to throw out its light can it be seen.* Were it not for the lights the larger bodies emit—with the exception of the sun and planets—the heavens would be a total blank, and not even the power of the telescope could bring the largest bodies outside the system into view. We are indebted for a starry firmament, not to the stars themselves, but to the lights they spread out. These continue visible in the cases of the great suns—and our sun undoubtedly ranks among the class, whatever his relative standard in magnitude may be—at thousands of times greater distance than they could be seen if they had only the silvered colouring of borrowed light. A body which emits no light of itself totally disappears when it is sufficiently remote for its disc to vanish, but if it is so related that it can send out its own native light, its position, if not itself, will appear at a distance according to its brightness and expansion, the brightness and intensity being in all cases strong or weak in the same degree as the body from whence they proceed is large, but in many cases considerably modified in relation to other lights. Jupiter, as an example, is a large body, but it gives no light, for the simple reason that its paler light is obliterated, even to the surface, just as in the case of the lighted candle placed close to the gas light. If it had a position among the telescopic stars, it would undoubtedly be a sun, perhaps a small one, even among these minor luminaries, and the light coming from it could only be bright and intense as to its magnitude. Our sun is a thousand times larger, and the volume of light is undoubtedly a thousand times greater than the light which would spread out from Jupiter as a sun. The one is of resplendent brightness, the other would be pale and glimmering; and if there were no other lights in the heavens but these two, the sun by his light would most likely show at a thousand times greater distance than that of the tiny twinkle of Jupiter.

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* The light of no one sun extends beyond where it meets that of another with equal brightness, and at the dividing line the lights of both are equal.

But the lights of a sunlet and a great sun contrasted singly by themselves, is not an apposite comparison in showing the effects produced by the great luminaries upon feebler lights. The true picture is the hundreds of monster suns dimming with their overwhelming splendour the flickering lights of the millions of little suns, which are dotted over the regions which intervene. We know, by experience, that in a small way artificial lights have the same effect upon each other. If the experiment were tried of placing over a very small limited landscape a number of electric lights at the proper distance apart, and also in the intervals innumerable lights, averaging a thousand times less illuminating power—the lights existing without the flames, which is the true nature of celestial light—not one of the latter would be visible, or rather they would be practically non-existent, for they would be all blotted out by the great splendour of the electric lights; whereas if these were put out, the smaller lights would at once in a subdued manner illumine the scenery. While the electric lights shine the others will give no light, but as soon as they are extinguished the little ones would spread out a feebler light according to their strength.

The lights of heaven act and react similarly upon each other in all respects. The mighty suns of space, few and far between, are the electric lights of the universe, and by their dazzling splendour blot out the millions of little ones which lie between. These, to the naked eye, are nowhere to be seen. But we are indebted to Galileo for the millions revealed to view, not in the intervals between the stars, for no invented instrument could reveal them at such a distance, but only over that expanse from the system reaching towards the nearest stars. At any greater distance than that in which these insignificant specks exist the telescope is powerless.

It is amongst these bodies that scientific men, with the terrestrial orbit as their base, might over so wide a field fathom the distance of some of them, and step by step finally be enabled to give vague outlines to our system, besides obtaining further insight of the uranological wonders which of late years Rosse's telescope has revealed. These are the utmost limits that human knowledge can at present have any hopes of reaching; and in the remote regions beyond, all we can know, or perhaps ever will know, is that at immensurable distance a succession of big suns like our own continue, and that they are the most distant objects of God's creation visible either to the eye or the telescope. We can, however, by the soundest analogy, infer that for each one visible there are millions of minor suns lying between. The operations of creation still going on, as we have already shown, prove that for every great sun which has been formed, there must besides be myriads of other primary bodies of more natural magnitude.

A broad comprehension of the action of lights on each other clears up many of the mysteries of astronomy. One of the most curious properties of the study is, that whether artifical or natural, no two lights can exist together in the same place. The weaker always gives place to the stronger as if it had no existence, and this accounts for the opacity of the planets. The light of the sun reaches them much more brilliantly than that natural to them at its brightest, and instead of shining they are shone upon. However, as we recede farther and farther from the sun his light becomes weaker; while the lights natural to the other bodies in the greater distance are of course the same wherever they may be. When we, therefore, reach the distance of the planet Neptune, from its magnitude we may reasonably suppose that its own native light is brighter at its surface than that of the sun at so great a distance could be. Should this be so, it is actually a sidereal body lighted by itself, instead of, like the other planets, borrowing its light from the sun.* If it is a luminous body, its own light can only extend to the distance within which it is stronger than that of the sun—a space round itself that must be very circumscribed, and which, like a planetary attractive sphere in a low solar latitude, is surrounded at a short distance by the prevailing brightness of the sun. At the distance that it is, after taking its magnitude and other facts into consideration, it is a question hard to be determined whether it is actually shone upon or is luminous in itself, but with the space it enlightens so cramped in that it presents to us at this distance no sidereal appearance. Its colour should be some index to its character, for we naturally look for a higher degree of brightness from native refulgence at a distance so great, while we might expect the reflexion of the solar light to be dim. Viewing it, however, all in all, if it is not a luminous body, sending out its light—like a candle near the gas—to a very contracted distance, but is beaten upon by the rays of the sun, it is a proof that in what is supposed a chilly region the sun's light is beautifully bright, but even should it have native light close to itself, there is little doubt but that in that high latitude and considerably beyond the solar light is all-sufficient for the happiness and enjoyment of the living. But there is a distance, be it more or less, in which the light of the sun weakens to twilight dimness; and there the largest bodies, no matter how little they may be in comparison with other suns, are sure to somewhat illumine the surrounding space. These are, if visible, the nearest telescopic stars; and whilst they are the nearest they very likely appear to us among the most insignificant of those feeble glimmerers.

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* It would be extremely hazardous to positively say whether Neptune is an opaque body or not; but it is in a position, considering its magnitude, in which we might naturally expect it to be sidereal, notwithstanding that it is a planet. The double stars in all instances are sidereal, both ruling and ruled; and it might be that the outer planet of our system, which we take to be Neptune, likewise shines with its own light, although the disparity between it and the sun is much greater than the difference in magnitude of the binary stars.

But we are now reasoning on a position so far from the sun that the discs of the largest bodies lying nearest the borders of our system, as so many sunlets, would be quite beyond the power of the telescope. It is, therefore, only by their lights that we could detect their positions, and we think the less their lights are circumscribed, if not too remote, they appear to us in the same degree more distinct; the intensity and brightness of their lights, which will greatly depend upon their magnitudes, must, however, remain the most important quantity in the consideration. Now the lights of the nearest telescopic stars, if not at a distance to be beaten upon by the glare of the sun, must at least be narrowed by a sunset halo, which, viewed by the telescope from the earth, if at all perceptible, must all but obliterate them out from view. A few thousand million miles farther out the same class of bodies would appear, we imagine, much more distinct; for at that distance, if not entirely free from the obliterating effects of solar splendour, they might yet be to such an extent free that their own feeble lights would be enabled to spread out to their natural limits, and therefore in the remotest of the two positions be in the same degree more distinguishable. In short, celestial lights act upon each other in so many diversified ways—lights crippling each other by their closeness of proximity, and feebler ones falling out of view in the presence of brighter—that there is nothing more deceptive than judging their remoteness or even their magnitudes from their appearances.* The bodies invisible to the naked eye beyond the precincts of the sun we have certainly, so far as they are concerned, somewhat vague to trust to, in the evidence given us by the telescope, proof incontestable that they cannot be extremely remote, while the stars are known to be far beyond—in fact, out of the reach of human discovery. They are the mightiest suns visible, which from their enormous magnitude spread out lights in the same degree of inconceivable brilliancy that show far out into space—so far that infinity is the only word strong enough to express the greatest distance some of them may be visible. The positions of many of them may be ten, a hundred, or even a thousand times the distance which science can fathom; but the brighter they are, quite irrespective of their showy bigness, they are likely to be in the same degree more remote. The light of any sun is bright according to its magnitude, while the stars that are to the naked eye pale and of low degree, may be on this account the nearest; and we entertain but little doubt that the distance of some of them ranking below the fifth magnitude might be made known.

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* In reasoning on supposed magnitude or the fancied distance of bodies beyond the system we have not the advantage of their discs, which are totally out of sight, but only their lights, to judge from. As these act so diversely in more or less obliterating each other, their appearance is at best but a deceptive guide either as to their magnitude, distance, or other observed relations connected with them.

While the brightness of light that a sun gives may be a leading characteristic of that class of stars which set the measurement of their distance at defiance, in revealing its existence by its light—which all stars do—the remoteness into space it will show while depending mainly on its brightness, the extent of area over which it expands must also be considered. Thus the light of any sun, however bright, if crippled, or rather surrounded by the too near proximity of kindred great lights, has its own body of lights narrowed in its natural expanse, and from this cause will show to a smaller distance. Our sun, for example—whatever rank he may hold as a star—is in a position over which his light expands to its fullest natural limits; but, to take an extreme view of the case, suppose he was placed sufficiently near another sun of much greater magnitude—and there is little doubt but that one of the largest created suns would fulfil our ideas—the effects would be as follow:—

The light emitted by the monster sun so placed would be in degree intense and bright according to its greater magnitude, and if it reached the surface of our sun stronger than his own light—this, if near enough, it must do—his light would vanish from the presence of the greater light, and as a body, instead of shining, would be shone upon. It would thus be bare and opaque, and in all respects reduced to the same appearance as the planets under him, with the single exception of comparative magnitude. As a body thus rendered opaque, how far would he appear? Simply to the distance within which his disc was visible, being lost to view at perhaps not a ten-thousandth part of the distance that his light as a star actually shows. Next, let us suppose that nature placed him in such a relation to other great lights that two suns of about the same magnitude would be —one on his right and the other on his left—at such a distance on either hand as Neptune.* So related, his light would only expand half way to either sun, which would curtail it within the comparatively narrow space of three thousand million miles. Thus he would show as a star to a much shorter distance than if in a position unhampered by other lights equally great. Finally, if his light expanded out to its widest natural limits, which is its true condition, and if we take the total diameter of the space it illumines with a degree of light fairly bright to meet human wants at ten thousand million miles in diameter, we can form a vague notion how far he would show as a star, supposing light continues visible as much farther than a solid opaque body as it is of wider expanse. That the sun enlightens space so far with a sufficient brightness for the happiness and enjoyment of life we have no means of knowing, but, all things considered, the supposition is not unreasonable. Now, if the light of a sun really shows at as great a distance according to the diameter of its expansion as an opaque body, there is very little doubt but that our sun is a visible star as far as would be the disc of a solid body ten thousand million miles in diameter, silvered over with borrowed light. At what distance such an enormous but impossible body would totally vanish out of sight we will not venture to determine, but in the latitude of the stars even that extraordinary disc expansion, if at all visible, would only be as a speck. If this is the true appearance—and we are calculating not on fancied but sound principles—we must conclude that our great luminary is in reality a star, but only of comparatively humble magnitude; the very lowest view we can take of our sun, for a hundred conclusive reasons could be given that he is not to be numbered with the telescopic suns. And when everything is considered in regard to the nature of light, and the wonderful effect that its degree of brightness has in making it show at distances inconceivable, we might hazard the opinion that our great light is a visible star, but of what degree of magnitude it is not given us to know.

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* At the stars three great suns so near each other would only appear to us as a single star, but this is in no respect prejudicial to the view we are taking.

Having thus far briefly given reasons why great suns in their unimpeded splendour are enabled to show as bright objects at immensurable distance, we may next offer a few remarks on the telescopic suns, which as a class in general are in themselves, however small by comparison with the largest known planets, no doubt huge bodies, which from their positions and the obscuring influence of the brighter lights around are blotted out of sight, and only magnified into known existence by the telescope—the most conclusive of all possible proof that, astronomically speaking, they are not very remote. To grasp and comprehend the secret of the existence of these innumerable minor suns and sunlets, we must take a very reasonable principle for granted, namely, that when the fiat of the Almighty first caused matter to originate, it generated by unknown natural causes in about equal proportion in all regions and throughout all space over which habitable worlds were decreed to exist. On the assumption, therefore, that matter is about equally distributed through space, the systems of the little suns, according to the expanses they take up, have an equal quantity of matter with the systems of the stars. In regard to their formation, attraction, but in a vastly greater degree the revolving motion of matter, led its atoms and particles into globes, and in extremely rare instances immediately prior to the formation of the secondary bodies from coinciding causes — which in the nature of things in one case out of a million was liable to happen—some chance infant suns became enormously enlarged by an overdue proportion of the matter concentrating to them, and as the first formed bodies of our star space, they have been enabled within their respective grasps to draw nearly all inert creation into themselves, leaving comparatively little for the formation of the habitable worlds to be formed in the future within the precincts of their rule. These are the bodies that make up our starry host. But the Creator is wise and perfect in all His works, and has so ordered that very few throughout space were, by their formation, permitted to waste matter by absorbing the materials of worlds upon worlds singly into themselves, leaving the precincts they respectively rule over comparative blanks. So few in comparison are these mighty accumulations of matter that for every one of them, judging from the number of the telescopic stars, there are millions of minor suns, each one of which within much narrower limits performs its functions with exactly the same perfection as any of its gigantic brethren. Besides, it is not unlikely but that smaller suns on an average rule over equally as great a number of worlds habitable in size.

Whatever by comparison our sun may be in magnitude, all his characteristics, whether he may be visible as one of the number or not, rank him as one of the stars. As before observed, his light spreads out in its unobscured glory and fullest strength to its natural limits, and within the precincts of his rule nature from the first gave him such a lead as to enable him to absorb ever since—in common with the other gigantic suns—nearly the whole of new created matter within his precincts into himself, for his incorporating power has only left to the planets under him a five-hundredth part of the whole. In her operations Nature is perfect, and the Almighty Being who set them all going never decreed nearly the whole of created matter to be lost in single bodies, each taking within itself the materials to spare, sufficient to make up ten thousand habitable worlds. Even by these monster creations creative wisdom shows perfection, for these mighty suns—taken together, compared with the other systems of the universe—are but odd solitary points in themselves, lost in the immensity, only in number sufficient to ornament the sky with their sparkling brilliancy.

How is it that there are a few odd suns—one amongst millions—monsters in creation, and that they get small in the descending scale to the lowest sunlets? Whatever may be their relative size we will not now discuss, but in a few words we shall express our conceived fancies upon the subject, without in this place giving reason or proof, and like all other ideas that are fanciful they are submitted at present for what they are worth.

In the order bodies were created, suns were first formed and reached perfection, but not their present magnitudes, before planets existed, and it is through the action of the suns that the latter—a work of time—have been built up. In their formation the great suns took precedence, springing up mostly at immensurable distances from each other—each one lost in the immensity, and solitary by itself; others followed of a lower order, step by step, in the descending scale down to the smallest suns that exist. During the time of their formation millions of years may have passed away, all according to their size coming into existence in succession, and each sun by its action forming its own system of planets—a work which is still going on in its fullest vigour. It will, therefore, be seen from this gradual order in the formation of primary bodies, that the great suns were the first-born of creation. Some of them existed by themselves long before there were other worlds, and the lower order of suns had yet to shine. Time was thus given them to become the mighty centres of the universe, and also in their several positions far apart to draw almost all created matter into themselves, and turn the wide precincts they respectively rule over into comparative solitudes. Our sun is one of them. Like the others he was widely isolated by himself, and as yet had no other rival suns near to divide with him the ancient galaxy. His power spread wide, he became one of the few centres into which creation flowed, and thus the materials that under ordinary natural operations would otherwise have reared up hundreds of habitable worlds, were incorporated in him, and to a less degree in the major planets, the natural overgrown offspring and creatures of his own greatness. It may seem strange, but these huge planets would have been of habitable size if our ruling body had been a sun of ordinary magnitude, yet the four minor planets would be much the same as they are—that is, if so many planets would, without prejudice to the natural operations forming them, have room within a system of narrower expanse.

If we reverse the picture and suppose the materials of the ten thousand million miles of space, be it more or less, over which the sun rules, had come into worlds the same as in the telescopic regions—and there were millions of chances to one that nature would have so ordered—something like the following would have taken place. Bearing in mind that there would under all circumstances have been the same materials, neither more nor less, let us imagine that instead of one primary centre as is now the case, there had sprung up ten solar centres, each one by itself and in its natural position. In that case the expanse taken up now with a single system would be subdivided into ten times the number, each system having an average area respectively of a considerably wider extent than the orbit of Uranus, while the ten separate suns would range in size from ten up to a hundred times the size of Jupiter. These suns with their systems would of course include planetary worlds, and, as applied to each sun, perhaps not so numerous, but of a more habitable size.*

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* According to our terrestrial notions, the major planets on the little dry land

Although this comparison is taken with the object of conveying what we imagine to be the condition of the telescopic stars, it is evidently too high for them in general. Suns, for instance, ranging up to a hundred times the size of Jupiter, would undoubtedly give out comparatively brilliant lights, which possibly might place them in the high rank of the lowest of the visible stars; but if not, it is all but a certainty that very few of the telescopic suns, at least those nearest our system, can be of such magnitude if they lie in the latitude from the sun we suppose them to be in. In short, the telescopic suns nearest our system, on the average, must be of vastly lower magnitude than the ten imaginary suns we have described; but although in one sense imaginary, from the natural operations at the beginning, many suns instead of one were then much more likely to be formed over the expanse taken up singly by our system.

To reduce the space taken up by the system into what we imagine might fairly represent the condition of many parts of the telescopic regions, let us, in the next place, suppose that at first the matter had so arranged itself, that a hundred suns originated within the limits ruled by our sun. On the former assumption that the total expanse is ten thousand million miles across, each one of the hundred suns would have, on an average, a system of about two thousand million miles in diameter, or sufficient space to give free play for the orbit of Saturn, and the hundred suns might be from the size of Jupiter to ten times the magnitude. In the event of the matter in the system having been thus, from the first, distributed, the same as we imagine it to be in the telescopic regions, the planets, suns, and habitable worlds would throughout the area have been a hundredfold in number instead of being incorporated and rendered useless, at least for the purpose of habitation, by the abnormal magnitude of one body, the sun. With this much more natural division of matter, we should have a comparatively thick sprinkling of perhaps hundreds of planetary worlds—none of them overgrown like our major planets—many of them habitable in size and visible to the sight, beautifying the heavens, thick as specks of silver, while still more thickly studded would appear the twinkling luminaries behind. It would not be one but several suns and sunlets that would be within near view, spreading out their feeble lights over the precincts of their respective systems. Feeble such lights would be as compared to the transcendent glory of the sun, as all these supposed lights being centred in himself, his light must be in the same degree brighter, but the weaker lights would be all sufficient to bestow the same happiness and enjoyment to

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which they possess, owing to the strong gravitation upon the surfaces of such large bodies, are thus rendered very unfit for the habitation of the larger classes of animals. The human race, we suppose, would succumb under such pressure, subject to it birds could not fly; but still very small animals and insect life might be in great abundance, and almost every variety of fish could enjoy life in their boundless oceans.

the living, and add equal, although subdued, beauty to the charms of nature.

If we could be translated amidst these minor suns, the celestial scenery would appear very different to that which we had left behind. Here we are nearly in the centre of a vacant space—it might be eight or ten thousand million miles across—with nothing visible to break the monotony, except seven planets so wide apart as to give little cheerfulness to the solitude; nearly all the rest of the matter, which in ordinary cases nature would have distributed throughout, being collected into the one body in the centre. Once outside this expanse—the solar system—we would be in regions thickly dotted with the planets of the surrounding sunlets—as a rule scarcely one of them overgrown, as is the case with our major planets—many of them fit according to our terrestrial notions to be habitable, and the background ornamented with the stars. Again, a still more cheerful view in the darkness of the night would be the halos of light appearing at the same time around, from perhaps a score of neighbouring suns. Their discs would most likely be nearly all invisible, but their respective lights being so comparatively near would no doubt as emanations from suns so small appear subdued and feeble, yet as spectacles they would be of sublime grandeur, serving to chase away the darkness of night, with fully as great effect as lunar reflexion.

On the assumption that over the endless regions they occupy there is as compared with our system an equal quantity of matter, as to the extent of space there would be over these regions the same proportion of light as in our system, with this difference that it would be more evenly and widely distributed, according to the greater number of luminaries, while the respective lights emanating from these solar bodies would, of course, be separately weaker, in the same degree as they are smaller. Any particular one of them, for example, if only a thousandth part the magnitude of our great ruler—or about the size of Jupiter—the light extending from it must be exactly in the same degree feeble. Light, therefore, coming from these sunlets in general must be much more faint than what we are used to. There is, however, light from any one of them sufficient for the wants and enjoyments of the living, and, what is best of all in the wisdom of Divine economy, not one of them can be in darkness. Light, an emanation like attraction—perhaps beyond human genius to account for—is common to all matter; consequently, where there is matter there must be light, and when the light natural to a body does not appear, it is simply obliterated out of sight by that of a larger body reaching it in a brighter state. Even a small planetoid which an acre of measurement would cover, if in a position where there was no light—if such was possible in any position of the material universe—would have in midst of the inky darkness a light of its own in proportion to its magnitude, but so feeble as to be imperceptible. A small asteroid, which is a body made up of several planetoids and aerolites brought by their revolving motions into one, would no doubt relieve the darkness near itself with a faint glow. In such an isolated and lone position the larger the body the brighter would be the light coming from it. How it is they all give out light, or naturally would do so if favourably placed for the purpose, is beyond human comprehension to tell, but all creation and the whole face of the universe analogically prove the important fact. It is not from the colour of matter that the light is in any degree produced, nor from anything in it that mortal eyes can perceive. The same can be said of attraction, and all we know is that in the matter itself we can see no light, but where matter is—if no brighter light from another body is present—a halo of light spreads out from it, feeble or strong, according to its magnitude. A careful study of the brighter and feebler lights which appear in the universe, and their action and reaction upon each other, would be of immense value in unravelling some of these celestial mysteries.

The little suns—the rulers of the telescopic regions—sending out lights comparatively weak, is no reason for concluding that the many habitable but unseen worlds subject to their sway receive a lower degree of heat. The idea is universal, but in the truest sense unphilosophical. The light that a body shone upon receives, we imagine, imparts to it the same degree of heat whatever may be the intensity of the light, for the heat is not produced by the light itself—it being an element in which there is and can be no heat—but simply by its presence in the atmosphere in which all the heat in a dormant state lies, being developed to a higher or lower degree, according to the density of the medium, and the direction the rays of natural light strike it. In these tranquil and happy regions we may therefore suppose that a great proportion of the myriads of worlds so thickly sprinkled over them are warmed by atmospheres, and that many are inhabited by perishable and immortal beings akin to the rational and irrational inhabitants of the earth. In regard to their age and maturity, these various worlds must be under grades of civilisation wonderfully diverse. Some of them, probably, are in their nonage, and not yet fit abodes for intelligence, while it is not preposterous to conceive, considering their antiquity, that many of them may have been in a civilised state for millions of years. What a grand idea it gives us of the perfection some of them may have attained through long ages of progress when contrasted with the earth, on which civilisation is barely in its infancy, for it first dawned upon us not more than four thousand years ago—a wide gap in time looked upon by itself, but only as a second compared to the age of creation. In our rude notions—rude in comparison to the advanced knowledge of the future—the perfection of civilisation should be wonderful on the earth a hundred thousand years hence, but the changes that may and most likely will take place during that time would by comparison make it fall below the perfect condition that numbers of these unseen and unknown worlds have attained through endless ages of progress.

CHAPTER XII.

HARMONY OF THE UNIVERSE.

THE doctrine of centripetal and centrifugal force, and the kindred idea of common centres of gravity, have of late years led some of the learned to form conclusions which, if true, show there can be no rest to any sun or system. Their primary difficulty is how such immense bodies as suns, inconceivably heavy as they must be, hang upon nothing, and that without falling by their weight somewhere, or, more properly speaking, nowhere. In regard to planets the teaching in question solves the difficulty of their support, at least, to their entire satisfaction, but the sun and stars —as far as appearances go—being all fixed bodies, the highest stretch of imagination had to be used to account for their support.

If it could only be shown that they had motion, they—as well as the planets subject to them—would be equally safe, for the stability of the universe is generally held to rest on revolving motion, and without it—so we are taught—all bodies would tumble headlong through the unknown; but, when we talk of tumbling down, properly speaking, there is no such thing in vacancy as up or down, right or left. As we stand upon the earth, guided by sensation, that which is below our feet is called down, and the direction overhead is up, while at the Antipodes the up and down are the same, but the directions are reversed.

To take another view of it, if it were possible to construct a machine that could be made to travel with safety to the moon, the passengers at first would be subject to the same sensation as when rising in a balloon. In their ascent they could not, to keep the moon in view, proceed in a straight line; but at a very rapid rate in their forward motion would have at the same time to follow her movement round the earth, yet no matter how curved and tortuous the journey, within certain limits the earth would still be perpendicular under and the moon vertical above them, and their sensation thus far would be that they were mounting straight up. In short, during the first division of their passage, wherever they would be, space in a terrestrial direction would be down, and in a lunar direction up. This would not continue the whole distance, but only to where the attractive sphere of the moon begins, and the instant their motion plunged them within it the sensation would be reversed—and while they are still steering in the same direction to the end of their voyage—the moon, instead of as hitherto appearing overhead, would be direct under; and the earth, in turn, be elevated above them. These reverse sensations would assuredly take place in a journey to the moon, if it were possible that human invention could enable man to live through such an ordeal. Viewing direction in this its true light should expose the inappropriate words of bodies falling in any nominal direction, for in vacancy there is no such thing as direction, and the term cannot be applied except on a line or lines between bodies. However, from their supposed inherent weight, the bodies without revolving motion according to the idea must fall somewhere or rather nowhere; but to the falling bodies—if it were possible that independent bodies could fall—at least the terms up and down do not apply.

It would, no doubt, be down in the direction that it was heavy, which heaviness would be imposed by the attraction of some other body of immensely greater magnitude drawing it into itself, and with which—except it may be one case out of millions in the character of falling aerolites becoming through mutual combination enlarged into planetoids—so soon as its gravitating motion leads it in, it becomes incorporated. These are the only class of bodies, mere handfuls of matter, which can ever be heavy, but they only exist unincorporated during their fall, in most cases in our abnormally wide system through thousands of millions of miles, while all others of larger size can never have weight as a property—objects and matter on their surfaces are heavy, but the bodies as wholes can have none—or be brought nearer the sun, or through gravitation into any other bodies, and that which is applicable to planetoids, asteroids, and planets, is equally so to bodies large enough to take care of themselves, suns. No bodies, however small or large, while they retain attractive spheres round them, or what is the same thing, are gravitating centres in themselves, can be subject to any exterior attractive force, except as governed bodies in their several positions, for the simple reason that no material forces reach their surfaces stronger than those inherent in themselves. The attraction from without cannot draw hence a single particle, because the force within holds it with stronger grasp; and what is applicable to all parts of the body is equally so to the whole, so that while this force continues superior within it the strongest exterior forces of material nature cannot place it in peril as a body, if its motions keep clear of the attractive spheres of greater secondary bodies. If weight could be imposed upon it, only to a single grain, every atom belonging to it would instantly gravitate to the new centre now acting with the stronger force, and the body itself would very quickly descend to its doom. No doubt, excepting suns, all bodies have revolving motion, for without it they could have had no existence, and, as noticed elsewhere, these motions give them no support, nor do they require any. If the rotatory motions, which impart to them their revolving motions, were to cease, they would remain still each one in its place the same as the suns which rule over them. On the ground, therefore, that all the secondary bodies of the universe require no support, and under certain conditions would stand still, the difficulty is at once met why suns remain safe, fixed and immovable in their places, without entering into the ratiocination as to how they are held up and supported. Creative wisdom has so constituted them in common with all other independent bodies from planetoids upwards, that when they reach a certain magnitude they require no support, and, because they are without weight, they hang serenely upon nothing.

Having in the opening chapter dwelt on the principles by which bodies are supported, or rather require no support, it is unnecessary in this place to follow it further. We may, however, try and establish the harmony of the universe by proving that suns are fixed bodies, and if they have systems of worlds under them, turn on their axes, but that they are without any other motion whatever. These facts being once made clear, universal harmony is proved, for the whole question rests on the fixity of suns, and their remaining eternally immovable in the same places. If suns stand still all is harmony, but if they move about it is impossible that harmony in an enlarged sense could be in any part of the universe.

In the first place, transits and eclipses prove that our sun at least has no motion, in obedience to the revolving motions of the planets, forcing him to go round a common centre of gravity; and, secondly, we think it should settle the question that no other sun imposes upon him revolving motion, for he holds precisely the same relative position with the stars as he did hundreds of years ago. So far, good; but it is held by many that a great central sun, a purely imaginary body, lies in some unknown position round which all the suns visible either to the eye or the telescope move in common, and that they being led round in one uniform direction no perceptible difference in that period of time in their relative positions could be observable. As a body, this central sun is taken to be so infinitely remote as to be beyond the power of imagination to conceive; and, indeed, in no other nearer position could it be, as all the millions of suns seen by the telescope, even on the side that we are in, must be vastly nearer. As, therefore, each one of these suns is supposed to be at a distance as great from each other as the interval to the stars, the remoteness that some of them must lie in is beyond conception, and as regards the mammoth sun which rules the whole it is in still remoter space far beyond.

If we are not mistaken, these grand ideas partly sprang from the contemplation of the star clusters of the telescope, and they have well observed that the lights of some of these bodies, since the days of Adam, have not had time to travel to the earth; if they had added that it would take ten times the period for the lights of the most distant to reach us from their remoteness, which is all but infinite, it would be nearer the truth. It is strange that it has occurred to no one to ask if it were possible that bodies, even the largest of creation, could be seen at a ten-thousandth part of the distance; but letting that pass, these inconceivable distances, and the millions of suns dotted over the great expanse, form but an insignificant portion of the sphere which surrounds the mighty central sun, so that hundreds of millions of other invisibles fill up the space on the other directions from us, right and left, up and down, and that to complete the outlines of the great stellar system. And does the idea of this wonderful system end here? By no means; for it is considered that the Milky Way is a composition of millions of millions of suns, which appear to us as a thin whitish vapour, each imperceptible atom of which represents a sun. As a point on this luminous background, barely visible from here, would represent thousands of suns, each one separated from the other as wide as from the earth to the stars, the distance to the end of these milky landmarks must be considerable, and all included within the mighty system of the great central sun. The position we are in, which is the space taken up by the hosts of stars revealed by the telescope and visible to the eye, is likewise held to be a part of the same white clouds, the millions of suns within view being, it is argued, separately distinguishable on account of their nearer proximity. According to such reasoning the mighty space over which human vision can distinguish suns, divided apart, would, the whole included, appear at the proper distance—how far distant it might be we cannot determine—a barely perceptible spot of galaxy in these endless regions of luminosity.

The central sun in question must therefore be a wonderful body to hold control over such a wide portion of the universe, including its thousands of millions of suns. Of what enormous magnitude it must be! What its measurement as a body is, it would be hazardous to guess, but to fulfil its great functions, the government of ten times the visible universe, as a solid body it would in diameter have to be as large as the expanse of space inside the stars! With no lower magnitude could it rule over so many great suns and their systems.

Some years ago an Irish academician published to the world that he had discovered the central sun we are dwelling upon, but no posterior facts have confirmed this, and, with the exception of that distinguished example, no one amongst the numerous believers in the theory have been able to prove its existence. Surely such a mighty body, at least equal to the dimensions we have supposed, should be seen at no matter what distance it may be—that is if other bodies in the same direction, infinitely inferior in magnitude, at such vast distances as they are held to be, in like manner are visible. The mighty ruler, if there is such a body, should be within view, if a hundred times more remote than the most distant stars visible. No such luminary has yet been seen, and we venture to predict that science will long continue its observations before a central sun is made known. The harmony of the universe is in no way deranged by the want of any relations of the kind, nor is any sun influenced in the remotest degree by another, no matter what may be its position, or the difference in their relative magnitudes. On this principle universal harmony exists.

The idea of a central sun might be exploded in a few sentences, but we take the liberty of somewhat enlarging upon the subject, for like many other false theories of late years it has captivated scientific minds and led them into wild conclusions by which, if true, harmony in the universe would be impossible. Our sun and his system, and the millions of systems which are visible in space would, as time progressed, be wafted round their great revolving circle, and all would be changing their relations to each other, and thus our earth, through being carried off into regions infinitely remote, would have new galaxies of stars in view. Subject to such guidance as a body it is here to-day, but in time to come might be as far off as the Milky Way, sweeping round a wide range of the universe in common with the suns which are visible. No rest to worlds under a universal movement of the kind could be possible; they would all be whirled away interminably for ever.

The hypothesis was imagined to account for the support of suns as well as planets, by their motions; the latter, on the principle of centripetal and centrifugal force, are according to their teaching held up by their motions, and, of course, the former to be safe must have these motions likewise. There is no scientific idea that the whole of mankind are so unanimous upon, than that the planets are thus supported upon nothing by their orbital motions, and they are thus perfectly logical in searching out for the same motions in suns, in order to do away with the difficulty of their support. Their logic, however, is at fault in the first step of their pursuit after a central sun. They have not legitimately followed up the idea of finding, or rather imagining a motion for the support in turn of the great central sun we have referred to, for it is evident that this mighty centre, together with a vast number of other central suns, must, to be preserved in common, roll round another centre still immensely larger. True, no one, although systems under systems of central suns may have been hinted at, has ventured to suggest a still larger sun which in turn lorded over a number of other great centres. One mighty central sun invented to satisfy their imagination, without venturing to look higher, very much reminds us of the reasonings of the ancients to account for the support of the world. They represented it to be on the back of an elephant which stood upon a tortoise, but what the tortoise stood upon was left an open question. In like manner, modern scientists, with extreme satisfaction to themselves, have explained how the secondary bodies, the planets, are supported by their motions, on the sling and stone principle, from tumbling headlong out of sight, and that the sun and stars remain apparently fixed, at least so far as their observations guided them; some—the idea is not universally adopted, for in the world of science generally it holds the dangerous position of a *questio vexata*—conceived the grand idea that the millions of stars, including the sun, were collectively subject to the mighty centre we have been dealing with. No one has ever seen or discovered this great ruling body, nor the least movement in the hosts of stars they supposed to be in subjection to it; but no matter, according to their reasoning, such a sun and such universal stellar movements must be, for how else could they be supported in vacancy? The wise men of antiquity made two blunders in their sage inductions, but the modern philosophers who have adopted the theory have only advanced one step, not venturing on the question of a second or higher centre; and so far as they have gone, compared to the ancient theory, theirs is still more untenable. If we, then, were asked how the sun and stars are held up, had we no better proof, we should say that the Almighty has made all His works so perfect that they hang with perfect safety in their positions through space, without any need of support.

In trying to establish the harmony of the universe, at least below the level of suns, our task is easy, for so far as human knowledge extends perfect harmony prevails. Take the solar system as our one and only possible example: although ruled over by a star which has irreclaimably incorporated the materials that by the course of nature should have made up hundreds of habitable worlds, leaving the great space all but an empty solitude, yet—irrespective of these defects in what the absorbing power of the sun has spared—undisturbed beauty and harmony prevails throughout. If we go beyond into the telescopic regions, over which creation is in a more perfect state, we can analogically conceive the same beauty and harmony to prevail over these immense, thickly studded regions. Even in connection with the wandering comets there is harmony of the most sublime description in their mission of life, flitting from system to system interminably through the universe, and, what may seem strange, their utility and harmony entirely consists in their erratic tendency. In short, through all material nature harmony is perfect up to suns themselves; whilst, as a class of bodies, if motion is imparted by their mutual action, or rather if they are all in motion in subjection to a mysterious centre or centres, harmony in the universe as a whole would be impossible. The movements of planets, with or without their moons, under suns, is the perfection of harmony; and that harmony is made complete if suns stand still, influenced not in the least degree either by their planets or other suns. To show that suns thus stand still in their places, we must have recourse to repetition.

1. Attraction is an active force over such regions of infinitude as are studded sufficiently thick with planets and suns, and the body which sends the strongest attraction over any particular portion of space, rules absolutely within its limits, and be they narrow or widely expanded no exterior body has the least influence.

2. All celestial bodies, excepting aerolites, have spheres of attraction round them more or less expanded, according to their magnitude and position, within which their own attraction is stronger than the attraction of any other bodies reaching them from without.

3. A smaller body can never influence a larger, and without

rotation a larger can have no power over a smaller, except that its stronger attraction would prevent any exterior rotating body from ruling over it.

4. A larger body, even if it has rotatory motion, has no power over a smaller one to make it revolve or rather to govern it, if the combined power of other bodies collectively is greater upon it. On this idea, so far as the permanent fixity of suns is concerned, will depend the value of the conclusions we shall submit upon the harmony of the universe.

The foregoing principles more or less ingraft themselves with the subject, but it is especially by studying the nature and relations of attractive spheres upon the largest scale that the question can be broadly grasped. As observed time after time, all independent bodies have their attractive spheres. Without them they could not separately exist, and would be incorporated into the bodies having the strongest hold upon them. The sun's sphere of attraction takes in the entire system, including the outlying irregularities dovetailing into the solar systems around, while all his planets, down to the smallest planetoids, have in like manner each their spheres of attraction. The latter are on all sides cramped in and surrounded by the predominancy of the sun to such an extent that all but four—if attractive spheres could only be visible — would appear as almost lost in the expanse. Yet while the planetary attractive spheres are comparatively narrow, they vary widely from each other, partly because of magnitude, but principally from distance. Near the sun, for instance, the terrestrial attractive sphere is contracted into about three quarters of a million miles in diameter, whereas if its position was out at the borders of the system, where the sun's attraction is feeble by distance, its attraction would predominate to a wide extent. Now, taking the four grand steps of the system, Jupiter, Saturn, Uranus, and Neptune, in connection with their magnitudes, these great planets must vastly expand their spheres of attraction as to their respective distances,—indeed so much that, from various causes, but more especially the measured intervals between them, we are led to believe that Neptune, the most distant, rules over a space which can be no less and it may be more than five hundred thousand miles in diameter. We also strongly think that this planet, for reasons we have already given, moves on the outer ring of the system. But it is too hazardous to accept the conclusion, nor is it at all necessary for the elucidation of the subject. If it is not the exterior great body subject to the sun, we must conclude that a fifth major planet lies in the space beyond. Should such a body exist, it cannot be less than a thousand million miles more remote; and, judging from the intervals as they progressively increase in breadth in the other steps of the system, we might put it down at nearly double the distance named. At such a distance this fifth body, supposing it to be as large as Neptune, would spread out an attractive area of its own, perhaps half as much expanded as the orbit of the latter, if the attraction of so small a body could extend so wide. The fact is, that in whatever manner it would be related to other bodies of its own class, in this remote position, so far as the sun is concerned, it would very likely be beyond the reach of his control. At all events, subject to these views, it shows the improbability of the sun ruling great bodies at such a distance, except on the irrational ground that all is an empty void to the stars, while on the contrary we confidently assert, without an iota of proof otherwise than analogical, that the vast extent is more or less thickly dotted with worlds throughout, a considerable proportion according to our ideas habitable, and many of them like our earth nurseries for immortal beings, whilst a few of them may perhaps be not very remote from our own system. On this assumption let us take the next step from Neptune, and instead of one thousand, four, six, or eight thousand million miles of remoter space might have to be passed over to reach it, not within our system, but as one of the nearest sunlets which we imagine are located outside its borders. It would, probably, be found to be a larger body than Neptune, and considering its proximity to the great light of the sun, the light natural to it, as a body would be so curtailed and feeble that it would be visible at but a short distance farther than if it was an opaque body. This, however, we consider as one of the suns with its system, whatever may be their magnitude and extent, which touch on our solar borders; and if we proceed sufficiently far into still remoter space, another sun and its system joining it will be met with; beyond it would likewise have a sun with its system—systems would be above and below it, and to the right and left there would also be small suns with their systems. Most undoubtedly, if the space near our system is taken up with planets and suns, the latter must be small or they would be more distinct to view. Thus this nearest sun beyond our borders would, as we presume all other solar bodies are, be surrounded by suns and their systems at all points, the system of our great luminary being one of the other systems mutually enclosing it.

Now, how is it that our ruling body can exert no iufluence over this border sun, whilst the next large body nearer him is made to revolve round as a subject body? Their respective positions answer the question. Neptune is so far within the sun's dominion that his power grasps it with greater force than all other bodies combined in opposition; hence its position forces it to succumb to him as a subject body. The next great body, the fifth step from the sun, which we suppose to be more than double the distance—except the abyss within the stars is vacant—is also surrounded on all sides with suns and their systems. Our own system touches its system in one direction, while it is bounded in other directions by systems above, below, to the right and left, enclosing it at all points. Not one of these surrounding suns, therefore, has the least influence upon it; for any one of them, with its predominant attraction, only touches part of its borders, and, as other suns have the same relations with it, so many opposing forces on all sides neutralise each other. We take for granted that our sun, as one of the number surrounding it, is vastly larger than the others, and, as we suppose, his power reaches thus far—attraction being a gradually decreasing force, it must dwindle down to nothing eventually—no doubt the smaller sun would succumb to his rule, and become one of the planets if it was free from the influence of the other sunlets. These surrounding small suns have, separately in themselves, forces of attraction, weaker in the same degree as they are smaller; but it is not the force inherent in a body which invests it with the degree of power it may exert upon another, but their relations as to distance. Our earth, for instance, acts with greater power on the moon than the sun himself, because of her nearness to us and her remoteness from the sun. The body in question being, therefore, so far removed from our sun and so much nearer the other little suns, hemming it in on all opposing directions, all, great and small, are liable to have an equal influence upon it according to their relations with it, and as the share of each separate sun acting upon it is not, perhaps, a tenth of their united forces, it is permitted, as all solar bodies are, to stand still, immobile in the speck of infinity in which it from the first existed. It thus remains for ever fixed in its place, on the principle that no body can be governed or in any degree influenced except by another acting upon it with greater power than the combined forces of all others in opposition. In short, a body to be subject to another, the whole or greatest part of its attractive sphere must meet the predominant attraction of its ruling body, and if it has no such relations, instead of being a planet, however small it may be, it is a sun.

Broadly viewing the question, all suns, wherever they may be, are with their systems surrounded and closed in by other suns and systems, and however different in comparison they may be, no one can be in the least influenced by another. The united opposing forces in all cases are sufficiently strong to neutralise a single force acting upon a sun, or, if it is not so acted upon, it is not a sun, but simply a planet subject to the one force holding commanding power over it. In one word, a planet is a body over which its ruling sun has greater power than all others in opposition, and is thus subjected to it by its rotatory motion; while a sun is so situated that several forces, more or less equal, beat upon its borders, no one having a preponderating power over all the others, hence no single one of them can give it motion. Suns, being all thus acted upon, in their several positions continue supreme as the patriarchs of the universe, and standing fixed and immobile in their places, the harmony of creation cannot be disturbed.

Such are the relations that suns hold to each other, but we may repeat that as bodies they reduce all others in a lower degree, as planets, to subjection under them, because they have more power over their subject bodies than the combined material forces acting upon them from without. From distance and other causes, when they cease to have this predominating influence, their systems, however wide or narrow, must terminate, and the termination may either be by exhaustion of force or by opposition. What is meant by an exhaustion of force may be thus explained. Suppose, what is generally believed—but we imagine far from true—that all is vacancy to the stars, the sun's dominion in that case reaches to all points of the sphere as wide as his attraction can extend, till it as a gradually decreasing force dwindles down to nothing, and within this area, whatever may be its extent—no doubt great, but far from what is generally supposed—all smaller bodies, however numerous, roll round him. This would be the natural limits of the sun's power if there is vacancy without; but as we are taking for granted, by analogical induction, that our system is confronted by little solar systems innumerable, his natural borders are cramped in by opposing supremacy. Indeed, the antagonistic forces begin within the bodies he rules over, as their spheres of attraction represent so much opposition, reaching out to the rank of solar dignity as far as they expand, and the fact of the major planets not being suns is only a question of distance and the magnitude of the unknown suns that may be lying outside our borders. Jupiter, for instance, in its present position, has we suppose an attractive sphere of not less than fifty million miles in diameter, whereas it would be fully a thousand million miles wide in the latitude of Neptune. In the latitude of Neptune he would still be under the sun, and as the smaller continue as a subject body wherever he might be within the expanse of the sun's attraction, if all is vacancy as far out as the stars; but if placed out where the power of the sun ends—still supposing all to be vacancy—Jupiter would undoubtedly there be a fixed body and an absolute sun himself.

This, however, is taking the extreme and irrational view, that outside our system creation is a blank; but if the expanse is what we hold it to be, thickly studded with the millions of telescopic suns under which creation in a more happy and natural state has its habitable worlds, thick as stars, Jupiter would be enclosed within nearer space according as he might be related to other bodies either as a planet or sun. As above observed, near to Neptune, his attraction would not be less than a thousand million miles wide; but it is evident that even with that expanse of rule as the sun is related he would still be a subject body. Imagine him to be another step—far enough out for the purpose—where would the sun's power as a ruling body over him be, with other bodies placed over the expanse at natural intervals immediately near or beyond? At such a distance perhaps his power—if there were no other bodies in opposition—would be at an end; but if not, with the presence of creation in the surrounding space, his influence over Jupiter would cease, as he would be locked in by the predominant attractive spheres of the bodies around him, and within which, in no direction, would the attraction of our great parent be predominant. In a word, Jupiter carried out so far would, in all likelihood, be an absolute sun himself, or he might still be a subject body, all depending upon his new relationship; but one thing is certain, he could owe no allegiance to his present ruler. The same reasoning is more or less applicable to the other major planets. If they were all shifted outside our borders they would have a chance of being suns in their several positions, but two of them would possibly rank in the lowest order.

Let us in the next place illustrate the nature of universal harmony still further by aid of the annexed figure.

Every separate opening in the figure represents the precincts of a sun, the enlarged space in the centre being our own system, and those surrounding the supposed systems of telescopic suns adjoining it. What may be the relative expanses of these small systems, if they really exist, round our borders, we are of course unable to determine; but, upon the assumption that they are among the stars brought to view by the telescope, their comparative smallness cannot be doubted, and the irregular outlines we have given them are just the relations which all the solar systems with their borders meeting must hold to each other.* Each sun, no matter where it may be, sends out a force of attraction for a distance, stronger than that of any other sun, and the minor bodies within its precincts are ruled over by it as planets if it has rotatory motion, but if it has not it is without subject bodies and solitary by itself.

Referring more especially to our own solar system, we see what is undeniable, its four grand and natural divisions, or rather the four great planets—in the telescopic regions large enough to be suns—and which have practically gathered into themselves the little matter left by the all-absorbing power of their great ruler for the formation of the planets in general. It may be truly observed that the sun has only spared a five-hundredth part of creation within his system for planetary formation, and out of this small moiety left these four planets have gathered into themselves, with the exception in like manner of a five-hundredth part, the only share of matter spared for the make up of the two hundred minor bodies in the system, from the earth downwards. In short, the sun has absorbed nearly all into himself, and, secondly, the major planets have in about the same measure incorporated nearly all of the little that is left.

Again referring to the figure, in our own system the dotted lines represent the supposed expanses of space contained within the respective spheres of attraction, or rather the limits within which the attraction of the four major planets is stronger than that of the sun. We can only deal vaguely with facts we cannot accurately ascertain, and we may, and most likely shall, widely err in the supposed measurements of space within these respective

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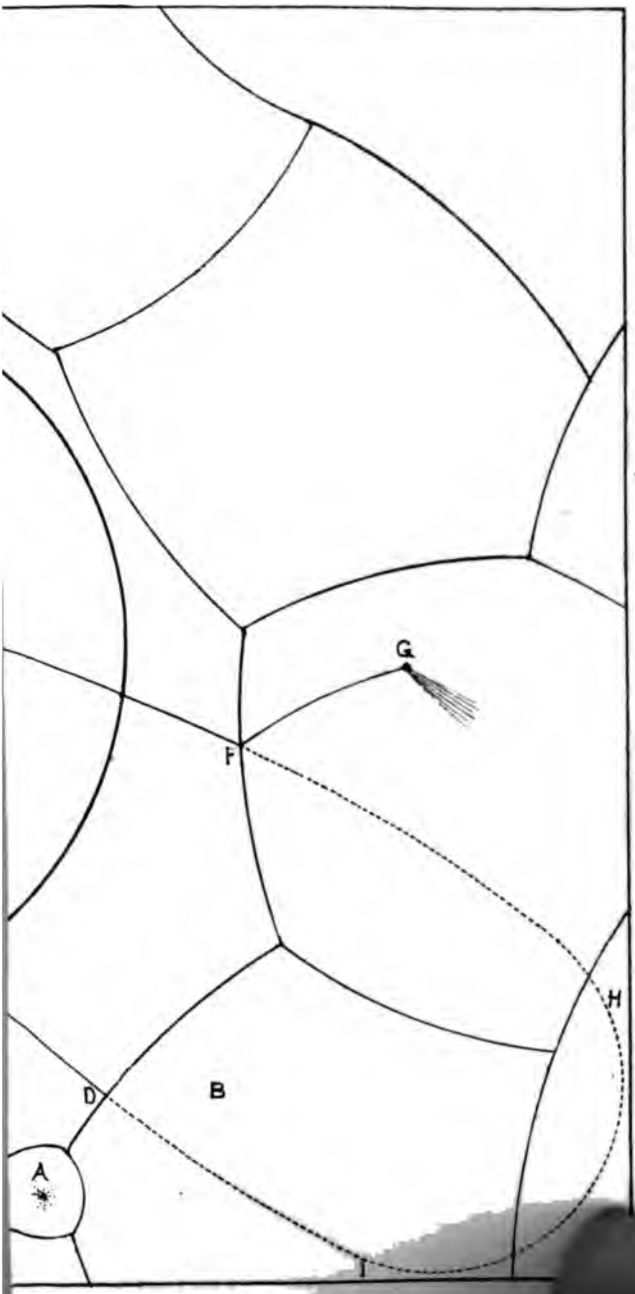
* The reason why our system is presented so little rounded in outline will be better understood in another part of the work.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spheres of rule, but, even so, it will in no way affect the general principles we wish to illustrate. Suffice it to say, that the first of these great planets, Jupiter, while it is the largest, its attractive sphere is the smallest, because of its nearest position to the sun. Saturn, the next in order, must have a much wider sphere of attraction, for it is a body little inferior in size and at about double the distance at which the opposing force of the sun becomes in the same degree weaker. The last is Neptune, which, as we have repeatedly observed, expands his rule over a space that may exceed half a thousand million miles across.

It will be seen that we have marked out the attractive areas of the three nearest planets as of spheroid form, surrounded in all directions at the dividing lines by the stronger attraction of the sun. On the least reflection, whatever may be their respective extents of rule, it is impossible to be otherwise. If Neptune is not the final step in the system, its attractive sphere would be surrounded by that of the sun in like manner; but as we take it to be the last in the series of the great planets, and, if so, the attraction of the sun at all times does not prevail to the other side, so that the system of this planet, during a part of its course, touches upon the outlines of those solar systems which lie nearest. Even if the position of Neptune is not the final step, it is of no consequence: it is enough that whatever planet it may be, if there are solar systems adjoining, it would hold somewhat of the same relationship we have given, and the last planet in our system must be so related, however remote it may be, if other primary systems join ours. Let us look at this planet as a body, whether it is Neptune or not, and see how it is related to our sun and the other suns which in any part of its course may lie immediately beyond it. It is partly laid hold of, as it revolves round, by some of these border suns, but in all parts of its orbit our sun has the strongest influence over it, and thus keeps it in subjection. If its position were at less than double the distance from us—if still a subject body—it is certain that it would not be influenced by our sun, but subject to some other sun with greater power over it in its new position, or it might be so related that no other sun could exert upon it the overbalancing force requisite to bring it under. In the latter case, however small, it would be a sun, a change more likely than not, for if there be any truth in our remarks on the telescopic stars, it is not the magnitude of a body in all cases which constitutes a sun, but its situation in relation to others.

This last idea may be made clearer by again referring to the figure. Let us take, for example, the very small sun A. Its little system is laterally closed in by the system of our sun on one side and by the suns B and C on the other directions. Now the body in question may not be larger than our earth, and it would be instantly planetised by the power of any one of the suns if the others surrounding it were removed, but they all exert upon it a comparatively equal influence, and the contending forces thus neutralising each other, the little sunlet remains as fixed and immobile in its place, and with as proud a supremacy and independence, as the brightest star. We might thus reason from system to system throughout the universe, and in like manner prove with mathematical certainty that the suns and their systems remain unchangeable, and that in the exact positions in which natural operations first placed them. This they do upon the indisputable principle that no body can be moved or influenced by another, except some one body has a stronger hold of it than all others in opposition.

It may be objected that we are proving the harmony of the universe on the principle of millions of suns existing throughout the expanse reaching to the stars—a truth not established by a single instance of direct proof. We have professed to submit our ideas as resting only on analogical proof, which, if erroneous, it is in the power of any observatory in Europe to explode in six months' time, and till they are thus proved to be untrue we shall hold to our opinions with extreme satisfaction. We are trying to prove the harmony of the universe, not from the fact of minor suns being thickly dotted through interstellar regions, but upon the principle laid down, that one body can only be moved by another when it acts upon it with greater force than the combined attraction of others which lie nearer in opposite directions. This would be true, under all circumstances, even if there was not a single sunlet in the universe. If we begin, for example, to repeat what we have said, and take as our basis the universal idea, that the stars are the nearest suns, that our sun is a star, and that they are all as widely apart from each other as he is from the nearest star, whatever distance that may be, still the reasoning on the same principle holds good.

Upon the supposition that suns are so far apart, and that creation is confined to stars, and the solitary clusters which are justly supposed to surround them, the first question which presents itself is, Do the attractive forces of these suns meet, or, what comes to the same thing, does the force of attraction from a body extend interminably into space? If so, the systems, or rather the attractive spheres of these suns, meet and join into each other after the manner of the figure, but which is meant to represent divisions of the universe vastly more limited. Still, we think no one will hold that the attraction of a body, no matter how large, extends out interminably into infinitude. The attractive forces of stars meeting implies the idea. There is no truth in science better known or so universally admitted than that attraction as a force gradually becomes weaker as to distance, hence we must conclude that what becomes gradually weaker, must at a certain distance dwindle to nothing. Admitting this as a truth, the sun and stars cannot extend, however feebly, their respective attractive forces a hundredth part of the distance into the intervals which divide them. Upon this principle alone, as suns, they cannot affect each other, for their attractive forces could not meet, and consequently, without the action of attraction, they would have no power to move each other; therefore no unharmonious results could follow.

Again, to resume the consideration of the force of attraction extending from bodies interminably. The idea is in itself irrational, but it is at least tacitly received in science, the expression being common that the bodies of our system are acted upon, however feebly, by the attraction of the stars. If such a thing were possible, that the stellar spheres of attraction would all meet over the interminable vacant intervals between them, still the harmony of the universe could be proved exactly the same as in the case of the systems we have mentioned, and which, if they exist, are vastly more contracted and microscopic by comparison. Take our sun for example. We presume he is nearly in the centre of a thousand visible stars; all undoubtedly great solar bodies, and perhaps equal in average magnitude. Of these great suns a certain number, say fifty—no exaggeration, broadly viewing the question—are with their systems the nearest, in the sense of meeting, upon our borders. Here, then, we have half a hundred suns all acting upon our sun in opposition. To have any effect upon him by imparting motion, it must be by the single exertion of one of them acting with greater force than the other forty-nine. This, of course, being impossible, our great parent is suffered to remain fixed and immovable in his position, without being influenced by any other system or sun, even on the irrational idea that the attractive forces of the stars could meet over such vast intervals as those which divide them. We need scarcely add that the fixity of every other sun can be established by the same reasoning—they one and all on every side are surrounded with suns, the same as our own. As the patriarchs of creation they hold the identical positions that the Almighty first placed them in, and, being thus fixed and immobile, the harmony of the universe is preserved.

CHAPTER XIII.

THE NATURE OF COMETS.

We can analogically draw the soundest conclusions on planetary bodies, for we live upon a planet, and have facts to compare with in reasoning upon other like bodies; but for want of these facts in treating upon comets, many of their peculiarities may for ever remain mysterious. There are, however, several characteristics connected with these flimsy bodies which are known to us, and comparing what we do know concerning them with what is unknown, it is possible that some of their peculiarities may in time be cleared up. It will be our present task to reason out a few of the questions relative to them, in due order, under the following postulatory heads.

1. Comets, in regard to bulk, we suppose, are the largest created bodies, and as they like the planets are laid hold of by attraction, they must be matter.

2. A comet is compressed into as narrow a compass as the nature of its materials will admit.

3. Comets are all subject for the time that they are under the sun to the same laws and government as planets.

4. Comets, like planets, can never in any respect be disturbed, at least in the sense taught regarding disturbances, notwithstanding the great eccentricity of their orbits.

5. Comets are constituted by nature to be wanderers from system to system throughout the universe, and we think their true mission is to give life to worlds they trip over in their erratic courses. The class of comets which are permanently held by the same suns are thus rendered useless for the purposes for which they were created.

6. All things created have their uses, and comets being bodies unfit for habitation, they otherwise must play an important and indispensable part in the economy of the universe. What is to be advanced on their utility may or may not be true, as our reasons will be entirely based upon remote and indirect evidence, as a whole too weak to set at rest a great truth, but the other enumerated heads admit of direct evidence.

In the outset we may dismiss the question of comets being composed of matter, by the simple remark that they are all subject to the government of the sun during the time they are retained in the system—a fact that leaves no doubt of their material nature. As they thus prove themselves to be matter, as everything that is visible must be, they, by the force of the attraction which is inherent in them, like all other bodies, compress their own atoms into the narrowest possible compass. All planetary bodies are compressed into the closest solidity by the laws of attraction to which they in common are subject to, and unless we are to admit the absurdity that the matter of comets can remain thin and apart and free from collapse, instead of clinging closely to the centre of gravity as other collections of matter which are attractive centres, there is no other conclusion admissible than that the body of the comet, as a whole, is as close and compact together as the nature of its materials will admit. Only take the comet to be matter—and that no one disputes—and the action of the whole on the several parts binds the mighty mass into the narrowest possible limits. Gravitation is imposed on all its atoms exactly as we see with regard to the materials of the earth, and hence we are enabled unhesitatingly to pronounce that, as a body, it is in as solid a state as its materials can be reduced to. We do not mean the solidity of the granite rock, or even that of water, but the kind of solidity which atmosphere is capable of attaining comes nearest to our meaning, and, whether right or wrong, we take the comet to be composed of vapoury material of some description or other. Its materials are, therefore, of the lightest description; but when we consider its enormous bulk, perhaps exceeding the largest suns, all compressed into the narrowest possible dimensions, we are led to believe that the average of matter in each one of them may be equal in quantity to the whole of the matter contained in the body of the earth.

This conclusion as to the quantity of matter we suppose on the average might be contained in comets, at an humble distance, runs counter to the authority of a distinguished scientist, for he has pronounced that the whole of the matter in any one comet, if collected together and rolled up in a kerchief, could be put into his greatcoat pocket. He, as well as others, admit them to be matter, and the materials of a comet on the average being stretched out a hundred million miles or more, he must consider them very thinly spread out indeed; but we must do him the justice to say that the expression may have been used figuratively. He had in his mind's eye the probability of a comet some time or other enveloping the earth—shocks that all who study the subject must know moderately-sized bodies are subject to—and consequently from the apparent infinitesimal matter throughout its length he was led to believe that in the event of a terrestrial transit through one of them there would be no serious results. That such catastrophes have happened to the earth there cannot be a doubt, and, from the arbitrary directions of all such bodies, they at very long intervals are liable to recur; but should one of these transits during his time take place, there would be a reasonable possibility of his not again philosophising on the subject.

His reasoning was entirely based on the supposed universal opacity of matter as applied to the composition of bodies. For instance, the materials of the earth he treads on are dark and opaque, so much so that a crust the thickness of common glass would occult the view of an object beyond it; and the stars being discernible through the bodies of comets with nearly as much distinctness as if there were no intervention, the learned conclusion is arrived at that if the whole body of the comet was pressed flat it would form a still thinner crust than the one referred to. The conclusion is quite natural on the assumption that opacity is common to the matter which makes up all bodies, but it never entered into his conception that there is a certain proportion of matter transparent—not of the transparency of glass or water, substances we can only see a short way through—but of such a pure transparency, that although pressed closely according to its nature, objects would be seen through it if it were millions of miles in thickness. Of such a transparency is the atmosphere we live in. It is supposed to form a layer over us of forty miles in depth, yet we see up into space with the same distinctness as though it had no existence. In fact it is indiscernible, and instead of forty, if it filled space for millions of miles out, there is very little doubt but that the sun and stars would be seen through such an enormous thickness of the medium with about the same clearness as through a comet. The puzzling question, however, may be asked respecting the dark haze which almost conceals the rising and setting sun. Thus in these lateral directions the greatest thickness of atmosphere has to be looked through to see an object beyond, and this nearly impenetrable haze intervening at the horizon to a considerable degree, obscuring all things beyond, may be taken as the clearest proof that the atmosphere cannot be of cometary material, or otherwise through so short a distance objects beyond could be discerned clearly. Our reply would be that the obscuring darkness or opacity in the atmosphere belongs not to it as an element, but to the water drawn into it by evaporation, hanging continually more or less dense in an imperceptible atomic state, up to the altitude of the clouds. In looking horizontally the eye has to penetrate the greatest distance through the aqueous vapour, and hence the ruddy haze which obstructs the view, whereas, looking upwards, the distance is short, no higher than the clouds, and thus no perceptible obscurity is produced. But even in this direction, where the veil is thinnest, these watery atoms impart to the heavens a different hue to that which the colour would otherwise be. An azure blue is what we are accustomed to behold in broad day, while aeronauts inform us that when they ascend high enough to be above the aqueous stratum the sky is of a dark indigo colour. It is therefore a moot question whether or not the light blue is caused by the solar rays upon the invisible atoms of evaporated water, which in greater or less quantity always hang round us, and form a considerable proportion of the breath of life we inhale. Be that as it may, if there were no water in the atmosphere there would be no ruddy haze forming an unbroken pall round our horizon, but as perfect a transparent clearness as at the zenith, and at the rising and setting of the sun the light would be of the same brightness as at noonday.

Whether the atmosphere is or is not part of a comet left as a mantle of life over the earth, there are some characteristics between the element in question and comets in general which bear a wonderful resemblance. As just observed, the purest transparency is alike common to them, and the anomalous manner by which attraction acts upon their materials is very similar. That atmosphere and comets are both matter we all admit; but it is matter *sui generis*, and it in all essentials differs as much from other matter as light from darkness. With the one we associate everything that is gross, but while thinking of the other we step from what is earthly midway into the realm of spirit. No wonder; for it is an element full of unfathomed mysteries—a virgin soil little explored by science, but rich in undiscovered truths, hanging as it were between heaven and earth. Its arcana are above our weak capacity to comprehend, nor can we understand why attraction acts so differently upon it to what it does upon other matter. Grosser materials always collapse into a nearly uniform solidity and density; but atmosphere, as a species of matter, seems to rebel against this force, and refuses to be contracted down to anything approaching a uniform density. It is most dense at the bottom, and gradually becomes more and more attenuated the higher we ascend, until at last, at an elevation of over forty miles, it becomes thinner and thinner, ending in nothing. Precisely the same apparent characteristic belongs to every comet. Although we have only our vision to judge by, no rational being who has ever beheld a comet could for a moment doubt that the same gradual attenuation of matter continues from its nucleus to the end of its tail. It is also one of the mysteries of these bodies that, instead of the globular, they take upon themselves conical forms; and the fact of attraction acting so abnormally on atmospheric matter may, if these bodies are composed of atmosphere, account for their shape. The atmosphere has a common basis to rest upon —the whole surface of the earth—and it falls alike upon all, getting denser towards the bottom equally round the whole orb. When, then, we see the wonderful manner attraction acts upon it we are led to fancy that, if it were detached from the earth, it might as a body of vapour actually mould itself into the comet's shape; but the idea is without proof, and we submit it just for what it is worth. At all events, comets, like the atmosphere surrounding the earth, have their materials most closely condensed, beginning at the nuclei, and continuing thinner and thinner throughout their entire length until, as is the case with the atmosphere, they gradually end in nothing. Thus, there are two essential attributes common both to atmosphere and comets —their perfect transparency, and the gradual thinning of their respective materials from below upwards. So far these facts prove their identity.

The nuclei of comets may or may not afford another proof that they are bodies of atmosphere, according as weight may be attached to the hypothesis about to be submitted, and in the support of which not a shadow of direct proof can be given: it depends entirely upon its plausibility.

In viewing the nucleus of a comet, its flickering appearance reminds one very much of a mighty body of gas flame—in some cases as large perhaps as the earth—which it carries with it as torch or beacon on its pointed end in its wanderings through space. The materials of the comet, if it is atmosphere, supply the necessary gases to produce and keep up the flame,* and there is only required a certain degree of heat to kindle it. That the comet at its nucleus has this degree of heat may reasonably be inferred from the known increasing heat of atmosphere, as to its density. We have no knowledge of the density of atmosphere being so close as to rise to burning heat; but in the long stretch in the body of the comet, its density step by step increasing, it is in reason that at least flaming heat might be attained at or before its conical point is reached. If this fact had direct proof as its basis, it would account for those bright appendages which belong to all comets, and it would afford a stronger reason for their being bodies of atmosphere than most other facts which could be produced.

If comets are bodies of atmosphere, they are apparently not identical in quality—that is, some of them may be composed of grosser material than others. To a certain extent perfect transparency is common to them all, but we think — it may be in a great measure imaginary — that those comets showing the brightest reflexion of solar light have their atmospheric matter in the same degree less pure. Comparatively speaking, the grossest atmosphere is pure, but there may be different degrees in their purity—the worst, according to our experience, may be pure, but there are purer and purest, and we may judge of their purity by the shades of colour produced upon different comets by the rays of light.

Let us take as our first example the great comet of 1843. It showed a bright colour, and seemed in general appearance, especially in the direction of the nucleus, like a cone of burnished silver. If colour is to be our guide, we should take it to be an atmospheric body of the grossest type. Again, we have Donati's and the one of 1874, the next two great comets in succession, and they, as bodies, were much less brightly silvered over. On that account we catalogue them amongst the purer class, and as there are others still less perceptible, so much so that were it not for their nuclei they might almost escape notice, still, although in the same degree of more refined material, we should likewise include them in the ative degree, and so on, until we reach the superlative hich only show by their nuclei. The atmospheric material latter, perfectly invisible, being purity itself without alloy, ose that men breathing it would have their lives prolonged ıries. Astronomers mark down this class as being without ıt it is a great mistake, for wherever a nucleus appears, ust be a tail, or else it would be no comet. Such invisible are perhaps but comparatively few, but their materials are perfect purity that, although they are each millions of ng and made up of compact matter—compressed as closely r as atmospheric material will admit—yet the rays of the not in any degree make them visible to mortal eye.

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* It might be supposed that a comet would thus soon burn itself out, but it would be just as rational to conclude that the earth diminishes through some of its vegetable material being consumed by fire.

exalted views these ideas give us of the unsearchable of the Infinite! Comets, we suppose, are created by Him w upon the worlds of the universe atmospheres, which we m their mantles of life, and, according to the comets they from, some get pure atmospheres, others purer, while it the lot of not a few to be blessed with the purest, capable g a state of life but one step below immortality. Atmo- nust be looked upon as the medium from which we receive along with it mortality. We inhale it as the breath of life, its action we gradually return to the dust. The degree of y, therefore, must more or less affect the living, and it may be mal life is wonderfully lengthened or shortened and made ɔr miserable by the atmospheres the various habitable have fortunately or unfortunately borrowed. It may be that in some of them, mantled round with atmospheres ct purity, life is prolonged to a thousand years, as Hebrew ı tells us was the case in the Adamic era, while the inha- of other planets, such as our earth in its present state, have e a grosser medium, which shortens life in the same degree ıy be below the standard of perfect purity.

CHAPTER XIV.

GOVERNMENT OF COMETS.

LET us change the subject and enter upon the government of comets, by inquiring in the first place why it is that their orbits are so very eccentric. Nearly all orbits are more or less eccentric—the planetary being in some cases compressed into ovals nearly twice as long as they are broad. The orbits of all comets vary from the circle still more widely; but after all the question is only one of degree, and the causes, whatever they may be, which lead bodies round on figures differing from circles, apply equally to both comets and planets, proving that the former, at least in this one respect, are governed in reality the same as the latter, notwithstanding the marked difference in the lines of motion they respectively take.

Planets are round bodies and nearly spherical, and it is remarkable that their several orbits in many cases correspond somewhat nearly in shape to the figures of the lines drawn round their bodies; but, as we have elsewhere observed, there are too few facts obtained by accurate measurements to establish what we firmly believe to be the truth, that orbits take their figures from the shapes of the bodies which describe them, yet for want of a better solution of the difficulty our reasoning as we continue the subject will be based somewhat upon the idea—still bearing in mind that if we are in error, our inductions, by the adoption of the hypothesis, will not be in the least degree weakened—that the same causes, whether known or unknown, which impart eccentricity to planetary orbits, apply equally to the orbits of comets, whatever may be their difference.

Taking it therefore at its true value, let us describe an orbit to be a figure which coincides with the shape of the body which describes it. The planet that is a perfect sphere, if there are any such, describes a circle which coincides, or rather lies, on the same plane with the sun's equator, the sun himself being exactly in its centre; but a planet which is not perfectly round goes on an orbit eccentric in the same degree, and is equally inclined from the equatorial plane of the sun, the position of the latter being as far from the centre of the orbit as it is eccentric. Now, on the supposition that these remarkable traits in the government of bodies universally hold good—which we do not venture to assert—comets being cone-shaped bodies, it follows that their orbits must be conical, and so far as they can be traced such is their actual shape, but as the tracing out of any cometary orbit can only be for a short distance, the missing link in the evidence, so far as these bodies are concerned, is wanting to prove the fact. One thing, however, in connection with them is undeniable—namely, that in all cases their orbits, whether conical or otherwise, are as oblong and narrow as they are themselves, and it is more than likely, with the examples of planetary orbits before us, that their orbits also coincide with themselves in shape as conical figures.

If we were to account for the eccentricity of orbits, whether of planets or comets, by the orthodox doctrines of disturbances, we should tread on safe ground, offend no prejudice, and everything would be pleasant, but as we look upon the theory as one of the greatest errors ever taught in science, we are forced to reason on orbital figures according to the light that is in us, and should we be floundering in a slough of error, the worst that can be said is that we are searching after truth in the dark. On the other hand, should our theory be true, it will enable us to pronounce that all orbits in figure coincide, at least in a great degree, to the shapes of the bodies which describe them. Planets are round bodies, and for that reason their orbits are round, while comets from their conical shape must, subject to the same law, describe orbits of the same figures as themselves.

In the long past planets have in some cases changed their rulers, and with but three exceptions, as regards our own system, comets are always changing, but no matter under what bodies or suns they may shift, if we have truth for our basis, their new orbits in each system, if fully described, would be the same exact figures. Our moon, for instance, was very likely for a long period an independent planet, but whatever may have been the length of time, she was in the first place under the direct government of the sun; by the same rule we can tell that her planetary orbit, if at that time of the same bodily figure, was identical in form with the more contracted one she now moves round under secondary subjection. In like manner, the portions of orbits which comets describe under the different suns they visit, are repeated in exactly the same figures, so far as they have room to be extended, as they go about in their erratic courses from system to system in their interminable wanderings over the universe.

The velocity of cometary motion is apparently another reason why these bodies, in this respect, are governed differently from other bodies. The rapidity of their motions while in view certainly far exceeds that of any of the planets, but when we come to examine the subject we find, like the great eccentricity of their orbits, it is a question of degree, which from what we know of planetary motion can be very easily accounted for.

As has been frequently observed, the sun's position is in the centre of an orbit that is a circle, but if it is not a circle he is never in its centre. The less circular the orbit is the sun is in the same degree—if a planetary body—nearer one end of the oval; and the planet's motion on the part of its orbit that is nearest the sun,

termed its perihelion, is more rapid, even when the nearness
position is allowed for, than when on any other part of its or
In other words, the rapidity of planetary motion is always acc
rated at the perihelion of an orbit, and the more eccentric it is
a figure, the greater the velocity at and approaching that poi
and the retardation at the remotest point from the sun is in
same degree equal, so that its rate of motion is balanced in g
round a mean distance in a certain time, the same as if it
passing on a circle at a uniform rate. Here is the true solutio
the wonderful rapidity of comets when near the sun; their or
are more eccentric than those of any other known bodies, and
passing, at and near perihelion, their motions are accelerated
in an equal degree by the same unknown law which adds to
velocity of planets when passing the same points on their or
As to their motions on the most distant parts of their orbits
course we have no direct evidence, as they can only be follo
to a short distance; but we may reasonably infer that acceler
motion being imposed upon them, similar in all respects to plar
they have retarded motions in their remoter positions, compensa
for their extremely rapid rates of travel when near the sun, and
the mean distance of the comets held in the system might be
culated to a nicety, exactly as in the case of the planets. In ma
such calculations both speed and distance would be quantities.
comet, for instance, in passing its perihelion, if its distance
the sun could be accurately known, its rate of motion, if
the shape the length and breadth of the orbit natural to it
body, whether there was room within the system for it or not, c
be told. Its rate of speed, beyond that of a body describi
circle at the same distance, would mark at once the degre
eccentricity by the measure of its accelerated speed, and thu
distance from the sun at its aphelion could be ascertained by si
calculation.

That comets move round orbits in a period of time as th
they were at the same mean distance on a circle is the only p
cular in connection with their government on which we cannot
direct proof that they are in all respects governed as the pla
The true reason, as before observed—the links of proof wanti
is that they cannot be traced throughout their courses in any
instance; but as we have proved, or shall prove, in every
respect they are acted upon as other bodies, it is not very hazar
to conclude that in this particular their movements in the re
space wherein they become invisible harmonise with the ot
Now, it need hardly be observed that the distance of a newly
covered planet in a very short time can at least be vaguely kn
from its rate of motion. At the outset the conclusion as to
tance, although not far from the truth, at the best can onl
uncertain, for, except it moves on a circle, its rate of motion
lerates or retards on the various parts of its orbit just as it hap
to be nearer or more remote from the sun. When once discov
however, it is sure not to be lost sight of, and the vagueness

culations every day becomes less, until at last, when it has
round half its orbit from the time of its discovery, they
the observations have been frequent and correctly taken,
reatest possible certainty as to its mean distance, its in-
from the equatorial plane of the sun, the figure of its orbit,
relative position to other bodies. If these particulars are
ly recorded, it is also known in the future the particular
the heavens it may hold in any day of the year; but as
comets in general no such particulars can be known of
ecause they perhaps never visit us but once, and only go
at part of their orbits natural to them as bodies the short
y are held in the system, but to the three comets which are
ntly held, if not the observations, at least the calculations
pplicable as to planetary orbits. Two of these three solar
-as we may term them—from their conformation and in-
nce, might be held long within the system, but in its
place we shall give reasons for supposing that Halley's
nay be only a sojourner. But letting that for the present
he motion of this comet, like the planets, is guided on all
its orbit by the law of mean distance—which there is very
son to doubt, notwithstanding that we cannot follow it to
test position—the distance it recedes could easily be told.
s departure from the sun until its return not being greatly
o years, or as it differs not widely from the periodical time
us, its mean distance cannot be much less. The eccentric
its orbit then must point to within a certain fractional part
le the distance of the orbit of that planet, minus the short
from its perihelion to the sun, and this would extend con-
y beyond the orbit of Neptune. If Neptune is the remotest
f the system, it therefore follows that the comet's orbit must
ery near to the dividing lines of the adjoining systems.
g that it is so related, as all comets are liable through
es peculiar to themselves—a part of the subject not yet
—to have their orbits enlarged, if any sufficient expansion
bit would some time place its aphelion the least outside our
its, once its motion led it back to that point it would then
r the stronger attraction of another sun, be carried off, and
ur system for ever. Should it ever be thus laid hold of by
e of the nearest suns it would, like most all other comets,
in become useful and be a wanderer from system to system
he telescopic suns, over regions where we fancy habitable
dot the heavens as thick as stars, bringing to those worlds
om in its wayward course it might trip upon messages of
t whatever may be the expanse of the system beyond the
this comet, or whether or not like other comets it may
ne or other wander from us, it will in its proper place give
is to reason from, which will enable us to infer that the
may not be greatly wider than the remotest point that its
ches, and, what is of more importance, the fact of its being
in the system will give us a very convincing proof that

the systems of the stars or the other great suns in the most ex cases cannot be expanded very much wider than our own.

In entering upon that part of our subject which we may cometary disturbance, we must confine our views to the solar comets, for that which may be advanced cannot ap wandering comets, and we suppose that all comets which ever visited the sun have been wanderers except the three k as Enke, Biela, and Halley's comets. Of these three, as information serves us, only one of them of late years has liable to the freak of having its periodical returns lengther shortened, but as all comets that permanently remain i system, and which have their orbits not too much inclined the planetic plane, are alike liable, we must generalise the su and, as in all other circumstances connected with the goverr of comets, our reasons will be based on the movements c planets.

It need scarcely be observed that all the known planets the system, except the numerous host of worldlings that stu asteroidal zone, have their respective orbits perfectly free* points from each other, without a single intersection or too an approach existing between any two of them. It, no d took a long period of time before this state of isolatior safety was produced, seeing that in the earlier stages of cre when of course bodies were much smaller, their orbits, be of their number and want of room to be clear of each crossed and recrossed at points innumerable, with as much fusion as the asteroidal orbits in our own time. From relations with each other at these points of intersection through their orbital motions became mutually incorporate in very rare instances satellised, until at last all that are reach of the telescope are collected into a few bodies so ind dent of each other that no operations on so large a scale are to recur in the future.

The orbits of the three solar comets, for these at preser what we have to deal with, have just the same relations t orbits of the planets—if their orbits are not too much inc from the same plane on which the planets move nearly in con —as the latter had to each other in their primal condition. is this marked difference, however, that it is impossible, their vast size and their vapoury material, that they can be wholly incorporated or permanently held in a lunar state, the case with planetary bodies when caught within the a tive spheres of other larger planets. The orbit of a come instance, is long and narrow, and in figure may be at one

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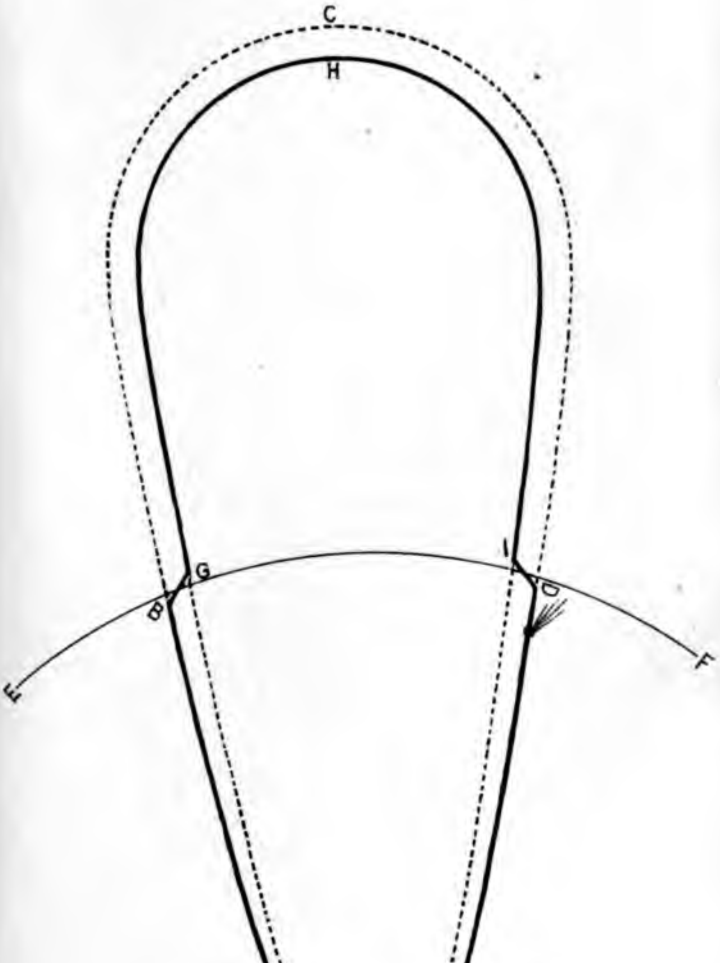
* There is very little doubt but that some, perhaps several, of the as intersect the orbit of Mars, and those which are so connected with that if they move nearly on the same plane—there is good grounds for conc they do not—are sure, one time or other, to become incorporated w The orbits of all the eight primary planets play free of each other, an the principle in view.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if not, at least equally elongated, and must consequently sing its course intersect the planetary orbits existing to nt it reaches. If the course of the comet be inclined rom the planetic plane, and it so happens that when any particular orbit, if the planet describing it is at or position at the time, the comet may or may not, ac- o the influence of the planet over it, be disturbed. For there is not one of the planets lying inside the orbit of hat has any power to disturb a comet so as to diverge it course, for if it, in its approach to or its recession from plunges into any of their attractive spheres—from their directions they are liable to do that—they are of so xpanse that the greater bulk of the comet, under any nces, must still be under the government of the sun. So refore, as his power is greatest upon it as a whole, their orces, when these enormous bodies are only in small in their grasp, have no effect upon them. While the the greatest portion of the body, he is supreme in the of its motion. The planets, therefore, which could omets, or rather deflect them from or retard them in rses sufficient to add to or shorten the times of their l returns, must be so constituted that under certain nces—which sometimes occur in the movements of lies—for a short time to become invested with a power n greater than that of the sun. The four major planets far as we know, could by reason of their wide attractive iold this temporary predominancy over comets, and we for granted that the irregularities in the periodical times permanently held within the system proceed from the ons of these four bodies alone.

e of the four but commands an attractive sphere perhaps n the total length of any one of the three comets. r it happens, therefore, that the comet in its course to the sun is crossing the orbit of any one of these planets, unged deep enough within its sphere of attraction, the the time being, holds the comet as a satellite under n, it being reduced into this secondary state from under t government of the sun. If the comet touches the of the planet in an outside direction so as at the same be in a sense partly subject to both the sun and planet, respect deviates from the solar government, notwith- its doubtful position, so long as the sun's attraction predominancy over it, and no irregularity follows; but ection of movement causes it to become so deeply in the attractive sphere of the planet that it has the hold upon it, as a satellite or moon, it is at once sub- in a secondary condition.

a planet is thus caught—an event that can only happen oaches near to or intersects the orbit of another larger f not incorporated, it can never again escape out from the thraldom of its lower subjection, for the very conclusive reason that it is a round body, and its orbit, under whatever government it may be, must be more or less circular, and on such a shaped course it can at no point reach outside the dominion of its new governing body. There, when once captivated, it must remain, but the conditions of comets under such circumstances are totally different. The orbit of a comet is long and narrow, and as it must describe the same figure, no matter what body it may be under, the instant it is diverted from its solar orbit by a planet it begins under its new character as a comet-moon to revolve on its very eccentric orbit round the planet as it did hitherto under the sun, but the time of its secondary bondage remains exceedingly short. Its new home or system is contracted, as compared with the solar system, within narrow limits by the preponderating attraction of the sun in all directions, and on its eccentric orbit it runs not only with its usual velocity, but in the same degree rapid as the axial motion of the planet it is under is quicker than that of the sun, and thus it very soon points out of the narrow sphere which it is in, returning once more under primary rule.* The very short time it is held, and the particular distance it may be led out of its previous solar course during its secondary subjection, forms the measure of the disturbance, and either lengthens or shortens the period of its return to the sun.

The solar comets would perform their periods to the thousandth part of a second, like the planets, were it not for the obstructions thus pointed out, and which they alone of the visible bodies revolving within the system, except the asteroids, are subject to. Whenever a comet is found to return at its exact time, it is certain that it has escaped all the great planets on its way, but if its time has either been added to or diminished, it has been temporarily held, and its periodical return either accelerated or retarded by being caught in some part of its journey in the meshes of a planet.

The importance of the subject inclines us to hazard repetition by, if possible, illustrating it more clearly by means of the appended figure.

Let A B C D be the natural orbit of a comet departing from the sun at its perihelion A. To the latter point it would unerringly return with the undeviating punctuality of any other body, excepting that it is liable to be entangled in the meshes of a planet or planets on one or more of the orbits it must cross over in its course. In passing these orbits, if the planet of any one of them happens to be at or so near the comet that its attractive sphere will for the most part, or wholly, envelop it, then the comet for a very short time becomes the satellite of the planet, out of the grasp of which it soon escapes under the government of the sun, and this, by reason of its conical shaped orbit, which must be the same, no matter how it is subjected or under what body it may be.

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* When comets are caught under secondary rule, if their motions are deflected sufficiently in an opposite direction from their previous courses, and if the interruptions take place in their recession from the sun, they are liable a second time to retrace their courses round the perihelion. Such was the case with Lexell's comet, the only secondary subjection of a comet ever witnessed. After escaping from the grasp of Jupiter it had actually to begin its journey *de novo* round the sun.

The comet in this particular revolution, beginning at its perihelion A, continues on its course—may be, passing over several orbits without any molestation—until it reaches B. Near B there is the arc of the orbit of one of the major planets, E F, and just as the comet is about to cross it the planet describing it happens to be on that part of it where the comet is crossing, the result is, its forward motion leads it within the attractive sphere of the planet, when it is of course at once satellised, but only for the time that the planet is moving from B to G. At this latter point, after a short detention, it escapes out again under the government of the sun, and that by reason of the elongated figure of its orbit. This deviation or disturbance—by no means a disturbance in the scientific sense in which supposed irregularities are received—it will be seen has narrowed the orbit, or rather the comet is shifted on the new orbit, G H I J. It is contracted throughout equal to the measure of the disturbance, so that its periodical time is in the same degree shortened at its return back to its perihelion A.

When we explain that in obedience to the rotation of the sun all the planets must revolve from west to east, it will be at once clear why the planetary obstruction thus described is not only the cause of placing the comet, as soon as it escapes, on a new orbit, but likewise of shortening, by that much, its periodical return to the sun. It is on a new orbit, for the simple reason that it must describe the same figure, no matter how narrow or wide the orbit imposed upon it may be, and the time of its return to the sun is shortened because its more contracted orbit gives it a less distance to traverse. The cause of the obstruction giving it a more contracted orbit is the planet's motion from west to east. Thus, as repeatedly observed, as soon as the comet plunges within the attractive sphere of the planet, it becomes its satellite, and as such, like other moons, it must travel with it at least for some distance eastward. Whatever distance that may be, the new orbit is narrowed to the same extent, and the time of its return equally shortened.

These disturbances in the one direction are in the end counterbalanced by an equal number in the comet's approach to the sun. All the planetary obstructions it meets with in its outward course, to a very limited extent in each case, both gives it a more contracted orbit and shortens its periodical return, while turning back towards the sun after passing its aphelion as it has to repass the same orbits described by the same planets—if caught in like manner the obstructions are of course repeated, but with this marked difference, that instead of its orbit being contracted and the ti of its return shortened, it is enlarged, and its visit to the s delayed, and by the self-same agency the easterly direction which all the planets move. In receding from the sun the d turbance leads the comet by the eastern motion of the planet an orbit nearer to him, and the same eastern motion during return places it on a wider orbit. Thus the outgoing and inco ing disturbances produce effects which reverse each other, the o having a contracting, and the other an enlarging effect, both regards time and place. If, then, the obstruction, as represent in the figure, had happened in connection with the same plan not on its receding course, but on its return to the sun at I, t effects produced would have been the same, but with this dif ence, that instead of a narrower the comet would have been l on a wider orbit after escaping out of the planet's grasp. At would be first caught, and the movement of the planet would l it captive as its satellite from its original orbit, the very short tance * from I to D, the point of its escape, where it would be on a new and wider orbit with a somewhat protracted period its return to the sun. It therefore follows that all planet obstructions occuring to comets outward bound have the effec narrowing their orbits and shortening the periods of their ret while in their homeward course, when they encounter the sa obstructions, their returns are retarded and their orbits enlarg As it is the same orbits which they have to pass and repass, the same planets that describe them, we may reasonably c clude that the disturbances fairly balance each other, so t extreme consequences from such causes rarely happen.

It may be, however, that a continued run of planetary obst tions in one direction, with few if any counterbalancing check the other, might during a lengthened period of time lead to curi results. Thus, if any one of the three solar comets—for it is o to these that such changes apply—happened to be caught planets in its receding course from the sun during a long success of revolutions, and, on the contrary, escape all or nearly all tanglements of the kind on its returns, its periodical times wo become very much abridged, and its position might be alte ominously near the sun ; but everything considered, we think possibility of being gradually contracted in so near as to ultimat fall into that body is improbable, for, strange though it may sou there is no other body in the system so powerless to draw ot independent bodies of matter into itself as the sun. In fact, he no power of the kind, except by sheer force of attraction—pow less upon bodies large enough to be attractive centres—as his fi position deprives him of the advantage of orbital motion for

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[*] The very short time any one of the major planets could hold a comet be fairly judged by the rates of their axial motions. The two nearest move their axes with more than fifty times the rapidity of the sun, and from revolutions of its moon we might conclude that this motion is equally rapi Uranus. Comets, therefore, which they lay hold of, must move as m faster under them as their rotations are quicker than that of the sun.

purpose, while all other secondary bodies have these motions, and by them they eventually captivate or incorporate the smaller ones which nature is constantly reproducing, and which at or near their intersections trip upon them in their majestic rounds. Still, the lion's share of creation goes to the sun, but only in the aerolitic or atomic state. Planetoids, or any other larger bodies, the sun has no power to draw in, and it being a principle so antagonistic to nature that independent bodies should ever descend on the great centre—planetary formation itself rests upon this principle—the same reasons lead us to the conclusion that no amount of contracting tendency could ever narrow the orbit of a comet step by step, the last one into the sun. A catastrophe of the kind would be opposed to all experience, and reverse the order of nature in the sublime beauty and harmony which universally prevail in the formation of bodies and the government of the heavens.

CHAPTER XV.

WANDERING COMETS.

It is the true mission of comets to wander—and it is by the same laws and government that keep the planets within their systems, that their erratic tendency is imparted—and when any one sits down permanently in a system, it is in a great measure, and we suppose wholly, rendered useless for the important part assigned to it by nature for the welfare of the universe. The laws of nature are seldom violated, and, as might be expected, few comets are rendered dead and useless—at least within our system. After the most careful observations which have been made for centuries past, we may pronounce with some confidence that the greatest number our sun holds permanently captive is three—two of them so insignificant that we may look upon them as comets beginning to be formed under the sun as their nursing mother, incapable during their nonage of wandering out; while, on the other hand, Halley's comet holds amongst such bodies a respectable standing, and we think as a permanent denizen of the system it is out of place. The secret of their wandering habits are the long narrow orbits peculiar to them, for which no systems are wide enough to give room. Since the beginning of creation and up to the present, from this cause alone out of the thousands—we might almost say millions—which have visited the system, only one had an orbit that could find room. All the others, from the remotest period, have burst in upon us from various points, and for want of room within our system for their long orbits have in turn vanished for ever. For one chance of any of these visitors ever returning there are, at least, millions of chances against the possibility. It is another proof of Creative Wisdom that such is the case, for their appointed mission is not one favoured system or another, but all systems over which they range, and their wanderings take them as far into infinitude as worlds exist.

We may describe the visit of any comet as a body coming into our system unawares—as all erratic comets do—at any point out of some one of the many systems that border upon our own and round the entire sphere. Previous to its plunging within our precincts it was temporarily subject to one of these border suns, and continued so till its orbit has struck the dividing line at D [See Fig., page 162], at which point its motion becomes deflected in obedience to the rotation of its new governing body, the sun.

From this time it continues under the latter, describing its long narrow orbit—which must be the same figure, no matter under what body it may be—in the direction of its perihelion E, which, as in all cases of comet visitors, must at this point be comparatively near the sun. From this nearest point it recedes from the sun, crossing half the system till it finally strikes out at F into the limits of another system, where in the direction of its motion it is once more turned by the rotation of its new sun on the line F G. It repeats the same course to a greater or less extent with this sun that it is now temporarily subject to, as it has just done previously under our own sun, shifting once again for want of room to the precincts of another sun farther beyond, and to another and another interminably—in short, it ends in this, that the real system of this, as well as nearly all comets, is not the narrow precincts of any particular sun, but the unbounded range of the universe.

It will be seen from the figure, which is not drawn to mark out the actual track of a comet coming in at random, but that a loose idea may be formed that to be in harmony with the rotation of the sun, whatever may be its first relations — which must wholly depend upon the point of entry—it is drawn from this inwards in the nearest direction to its perihelion, during which time it gradually moulds its movements to the rotation of the sun with an inclination to the ecliptic more or less according to the direction of its approach. If it could not shape its orbit at once to the legitimate form, the true permanent shape would be assumed eventually in the orbit D E F H J, and this it would describe for ever under the sun, if the system was wide enough to hold it; but it will be seen that for want of room it hits upon another system at F, and thus, as an ephemeral subject body, passes away from us never to return. Most other comets travel hence in like manner, and their shifting for want of room from system to system is in reality only a repetition on a larger scale of the planetary obstructions already described, which the solar comets sometimes encounter.

Comets, from the above causes, being enabled through the shape of their orbits to shift from system to system, two important facts by these movements are established—namely, that our own system is too narrow to hold them, and yet as a system it cannot be much smaller than the systems of the other great suns, the stars.

First, that the idea may be made clearer let us lay down a truism that no one will question—that our system spreads out in all directions till the attraction of the sun entirely dies out from distance, which means an empty void, or else it is bounded in within narrower limits by meeting other attractive forces stronger than that of his own. Whatever distance that may be, on either supposition, one of which must be true, of course we cannot tell. Many students would say it was half-way to the stars, but here is the undeniable fact of nearly all comets shifting out of the system by reason that there is no room for their orbits within it, which proves that it must be confined to narrower limits than a space wide enough for their orbits; and except on the absurd supposition that they run on parallel lines interminably—for no other figure could apply that would reach midway to the stars—we must conclude that the expanse within the system is comparatively moderate, when it can be so clearly demonstrated on the soundest principles that there is no room within it to contain the orbits natural to comets as a class of bodies. As they then have no room, what is immediately beyond must unquestionably be stronger attraction, for that, and only that, can limit the boundaries in regard to room, and as the attraction is there so must the bodies be from whence it comes. Here is a wonderful proof of the existence of the telescopic stars close to our system—as pointed out in another chapter—which in all directions round the sphere hedge in our system on every side, within limits so narrow that nearly all the thousands of comets that have dropped in under the sun, through the ages that are past, have found the expanse too contracted for them to remain permanently within it. Nay, we further believe that in the solitary comet of respectable size permanently held in the system—Halley's comet—we have an index that approximates to the true expanse of the system. Not at all points, for we may reasonably suppose that the system at some parts extends at least half a thousand million miles farther than the line of its orbit, but that is a fractional difference, moderate enough compared to the extent. Whether it be more or less, we look upon this comet's orbit as an uncertain landmark by which we can at least judge that the dominion of the sun extends no unreasonable distance beyond.

In the first place, we take it that comets within the system are in all respects governed the same as planets, hence, if we know their periods we can tell their mean distance the same as we can do that of the planets, although we cannot follow them as we do the latter round their courses. This principle being granted, roughly speaking, the distance that Halley's comet recedes is considerably above three thousand million miles, and it is the only real comet that the expanse of the system gives room for. Certainly there are the comets Biela and Encke, and we suppose others of a lower grade unknown and invisible, but these have never been out of the system. They are of solar creation, matured so far up out of insignificancy as to be visible, but they hold just the same relations to comets as planetoids and asteroids do to planets, and are unquestionably destined to become incorporated with the first large comets that in their random directions may stumble upon them. Halley's comet is in like manner liable to collide with other comets, for they are so uncertain in their movements all bodies not large enough to govern them are equally liable to be hit by them; but then we must look upon it, not as a cometoid, but a comet, that in a certain grade takes rank with the highest class formed by nature to meander at will throughout the universe. Of these, the most *majestic* of all created bodies, it would be no exaggeration to affirm that millions have dropped in and out of our system since the time our luminary was first formed, and out of the enormous number only one — Halley's — so far as is yet known, has found room for its orbit. The orbit of that comet stretches out beyond the orbit of Neptune. All the other thousands would have been held in like manner, but the orbits natural to them as bodies were too long and eccentric, so they are driven hence simply for the want of room. Halley's comet, the solitary exception, has room to remain at least for a time faithful to the government of our sun, and the period which it takes on its orbit may be looked upon as only a small fraction below the minimum of time some of those great comets that have in the past visited our system would take to pass round their orbits, if they had any systems or expanses wide enough in the universe to hold them—which they have not, or time would long since have put an end to their wanderings by being retained permanently within systems expansive enough for their eccentric figures. At all events, Halley's comet describing its orbit in 75 years is a kind of guide in judging the question, it being the only one held in the system that properly speaking can be called a comet.* It gives us undeniable proof that the system not only extends out as far as it recedes, but also that all the comets of the past have had no room within it for their orbits. Halley's comet is held simply because there is room for a 75 years' orbit. It would, no doubt, take hundreds of years to describe a large proportion of the orbits of other comets, if there were openings anywhere wide enough to hold such figures, yet the periodical times natural to them must graduate down to some step next above that one—in the truest sense a sister comet—and there being no room in the system for a single one of their orbits, as otherwise they would have been held captive, is indirect proof wonderfully clear that the orbit of Halley's comet reaches to within a short distance of the solar borders.

The wanderings of comets likewise establish the fact that our sun holds rank with the stars, and may in comparison be of average magnitude. Thus, if the reasoning holds good that all bodies, from planetoids upwards, have their spheres of attraction according to their positions and magnitude, it follows that the stars or great suns must have their respective attractive spheres or systems wide in proportion to their greatness. We can guess at the expanse of our own system, which at least proves itself wide enough to hold one comet. Other stars are, no doubt, larger, and perhaps some

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* Encke and Biela, together with perhaps many others that are invisible, we suppose have the same relation to comets that planetoids and bodies gradually rising above them in size, up to asteroids, have to planets. We uppose that comets were in the first instance all nursed within systems up o the maturity of perfect comets, or wandering bodies. These two are as yet in the embryo state, and time might enlarge them into the dignity of having the universe for their system, but they are far more likely to be incorporated at an earlier date by large comets that may trip over them.

of them may be smaller, and it is natural in the largest
there might be one or perhaps more than one comet helc
the grand fact remains that there are no systems—at leas
corner of the universe—wide enough to hold in comets as
for if there were such great spaces ruled over by single b
comets continued to shift within their precincts, they w
there held, and a work that had been going on for all p
would long since have imprisoned all comets within thes
tionally wide expanses, and thus there would not be on
move about on the mission of usefulness for which they
been set apart by their Creator. They still, however, visi
go away never to return, and these visits are, no doubt, as
now as from the earliest times : hence the systems of the
suns are too narrow to hold them, with the rare exce
perhaps one in ten thousand, such as Halley's comet.
therefore, could be clearer than that very few of the great
that so thickly stud the firmament greatly exceed our sun
nitude, for if they did, all comets in course of time wo
been caught inside their wide limits and held permanently
Nature has made them as a class of bodies that no system
can hold, and the momentous duties they perform in the e
of the universe depends upon the principle. Yet our grea
is wide enough to hold one of them captive—thus by its a
expanse violating the dictates of nature, and at the sa
establishing the fact that not many other systems can
much wider than our own.

CHAPTER XVI.

BESTOWAL OF ATMOSPHERE.

to explain the purposes in the economy of the universe
comets were created, we may be allowed to make the
ry observation that there are none of God's creations but
r uses. The least and greatest of His works are in some
whether known or unknown, indispensable for the very
of some other departments of creation. Thus, without
there would be no worlds to live upon, and matter would
over the great abyss in its pristine atomic state. Without
re there would be no heat, and without light there would
e. The former grand force keeps the materials of the
lid together, and without the latter elements they would
eless for the purposes they were created. Comets, there-
to bulk, being the grandest and most majestic of all
cannot have come into existence for no useful purpose ;
he universal elements referred to, must be indispensable
themselves or the worlds they visit. They cannot have
ent utility applicable to themselves, for they are uninha-
ence their utility—for, like all things else, they must have
s—must apply to the more solid bodies among which
derings lead them ; and, whatever messages of kindness
their mission to carry, we believe them as great creations
ndispensable as the light of matter which gives life, and
ion which holds the worlds compact and firm together.

ve submitted our feeble description of the government of
ith unshaken confidence, as we were dealing with truths
contestably prove themselves by the testimony of facts.
ately we cannot put forth our views upon the uses of
ithout hesitation, for, at the outset, we have to take for
he vital principle on which our reasoning will be based—
hat comets are wholly composed of atmosphere. From
e of the subject then, we can have no other proof except
ces and circumstances already noticed, and which need
eated; but our premisses will be more or less strengthened
t evidence, yet not of that conclusive nature which should
question at rest.

he assumption that comets are bodies of atmosphere, we
more repeat that in their movements they submit to no

fixed rules, wandering at random from system to system, up and down, hither and thither, as they may be acted upon. In entering a system the same uncertainty attends them. They are liable to shoot in at any point round the entire sphere, and during the time they are held by any sun, although they in an irregular manner conform to its government, they must during the time of their subjection be somewhat inclined up to the planetic plane from whatever contrary positions they hit upon when first entering the system. Their movements, therefore, even when within a system, from these causes, are to a certain extent vague and uncertain. No matter at what points they may come into a system, or however their motions may be guided within it, the directions they take are as random shots, which are liable to hit any of the bodies in the system below a certain magnitude happening to be in their way. They dart in at one point, and from thence move as direct as their government will permit to the perihelion, from whence they shoot off in another direction, cross a full radius of the system, and strike under the sway of another sun. As they come into the system at any points they may arbitrarily touch upon, and go out with equal uncertainty, they move—with the exception of obstructions, which upon rare occasions they meet with from the major planets—headlong through their whole courses, in and out, and whatever planets happen to be in their way, if below a certain standard, must pass through them. In other words, comets in all cases shoot in and out of systems at random and in any arbitrary directions, and whatever bodies lie in their way are, if of moderate size, swept by them, and the uncertainty of their movements being the same in all systems, the principle applies universally.

From the nature of the subject, we may reasonably conclude that most planetary bodies liable to such encounters have, at one time or other, passed through comets; but no matter how frequent it may have been the lot of any particular one to have gone through the ordeal, it still continues equally liable, as well as all other minor planets. Comets will shoot through systems, and if bodies are at the right time on their line of motion, they must of necessity pass through them, however frequently repeated. No doubt, since creation began, these repeated cometary transits have been with some planets frequent, but with a few in comparison only once; and it is not impossible that a very limited number—our moon is one notable example—have never been in the embraces of these wandering bodies.

When a comet is about to visit the system, if the point of entry could be previously known, and the direction of its course through the solar precincts calculated, it would be easy to ascertain whether or not it would trip over any planet on its way. These conditions being impossible, the uncertainty must therefore continue, and thus its passage through the system being without warning, every planet liable to such ordeals runs a certain risk, however remote, of being hit by it. In short, the comet's passage across the system whenever it takes place, and such occurrences e frequent, can only be compared to a shot, without aim, assing at hazard on a curved line in any chance direction, all epending upon its point of entry, and this may be anywhere round the sphere, and if a planet happens to be in the way of the reat projectile, it is hit, but if no one is tripped over, the comet asses out of the system without having effected any changes. This latter condition holds good in the instances of nearly all omet visitors. We have entered into no calculation upon the ubject, and may consequently err widely in our remarks, but we hink that in the passage of any one comet through the system here may be at least a thousand chances to one against its coming pon any of the planets, and ten thousand chances in favour of he escape of each one singly. There is one ominous circumtance, however, not to be lost sight of, namely, that the planets ear the sun—and the reasoning applies strongly to the earth—re more liable to the ordeal than those which are more remote. However, broadly viewing the question, we may rationally conlude that long intervals of time may be expected to elapse etween comet visits to any planet in particular; and their repective chances of escape might be rendered more clear by the ollowing comparison. Suppose a dozen targets of the usual size vere placed in the firmament over a square mile of space, if an rmy of infantry at the same distance were to fire at random mongst them, taking no aim at the targets themselves, the hances are that a hundred thousand balls would have to be fired efore a single shot struck a single target. True, these military rojectiles are small, and comets as projectiles are vastly larger; nd thus it may be urged that the comparison breaks down. We hink otherwise, because the targets, compared to the mite of pace they occupy, are immensely larger than the planets separtely compared to the expanse of the system; and thus viewing he comparison as reversed, we find it legitimate. From it, then, we may reasonably conclude that, although we lie in a more exposed position than some other planets, a good proportion of a hundred thousand years is likely to pass away on an average between each successive transit of the earth through comets.

That all moderately sized planets are, and ever will be, liable at one time or other to be swept by comets, whatever the intervals of time may be between the successive transits, are facts which we think must be received without hesitation by every reflective mind who has studied the nature of cometic movements. This preliminary then being granted, we tread upon safe ground in proceeding to describe the result of the first transit of the earth in its virgin state through a comet. The same remarks are likewise applicable to all planets which have passed through such changes, which all habitable worlds must have done at one time or other.

When our globe was first buried in a comet it was younger and of smaller magnitude, at what relative period in creation we know not, but it must have been in the long past, as the event preceded all stratification. No living thing was then upon its surface; all was dry rock, without a sign of moisture, purely primeval, without a blot or stain from elemental action, there being no elements except light, which was powerless in itself to produce any effect but that of chasing away darkness. There was no heat, no water, no springs, rivers, or seas—all was still and calm, not even the gentlest air, wind, or tempest. It was the calmness of death—no, not of death, for without life there can be no death; but a scene of dreary desolation, a world without life, and perfectly useless for the purposes the Great Creator designed in bringing its materials together.

Such must have been the condition not only of our own but of all other worlds in their primal state, and they would have thus remained for ever only barren collections of matter, had not He who made them at the same time created comets, as mighty messengers of life, which were constituted on purpose to travel through the universe, and bestow as they wander to and fro life to dead worlds. Some of these latter have never yet been favoured by these heralds of life—our moon is one example, being still in this respect in her primal condition; but through their agency, it cannot be otherwise than that a vast majority of planetary bodies of a certain magnitude throughout the universe have, at one time or other, already borrowed from them their atmospheres.

At what relative period of creation the earth, with which we are more immediately concerned, obtained its atmosphere, we have no means of knowing; and it could only be determined by the impossible task of digging down through the whole thickness of the strata which surround it. It may have been first invested with it when young and small. If so, stratum upon stratum superimpose the whole depth of more than two thousand miles—that is, if internal heat has not obliterated the epochal rings so far down—or it is not improbable that it had risen almost to its present magnitude as a globe before it enjoyed the blessings of atmosphere. And if we are to judge by the decreasing vestiges of life, as far as human research has yet been enabled to descend, this latter view is the true one. It is really not essential, however, to the line of reasoning upon the subject, at what relative period of creation the first cometic transit of our planet took place. It is sufficient for our purpose that such an ordeal at one time or other was sure to take place, and when it happened, be it early or late, the effects produced would under any circumstances be the same, and may be described as follows:—

The primeval and barren earth was at a certain time passing serenely round its orbit as it previously had done without interruption, it might be, for millions of years previously. It would have gone on in this useless state of tranquillity had it not so happened that in the particular year of the event a comet was within sight, and just at the right time, the earth being on that part of its orbit the comet's course was intersecting, the inevitable result was its transit through it. The earth being once within the comet, the atmospheric materials of the latter, surrounding it on all sides, were acted upon *instanter* by its attraction, which for a short distance out was stronger than the same force of the comet within the narrow bounds immediately surrounding the earth's surface. All that part of the comet, therefore, within that distance, necessarily clung to the stronger attraction of the latter body, and in the face of all opposing force permanently remained with it. With this firm and safe hold of its new covering, the earth, by the extremely rapid motion of the comet, was very soon left out in the open, plus the quantity of atmospheric matter its attraction was strong enough to hold to itself in opposition to that of the comet; the latter going hence, perhaps never to return, and deprived just that much of its bulk—a portion infinitesimal compared to its enormous size.

Here the thread of the description must be broken, as we cannot enter upon the results following this first great change in our planet without repeating what we have hinted at elsewhere, namely, that in material nature there is no liquid. What are termed liquids are but certain states of matter produced by heat. If the heat is of sufficient degree it is powerful enough to liquefy all matter, even if the element was so extensively applied the globe itself would be rendered a boundless ocean of melted liquid without a bottom. Briefly told, all matter in the presence of sufficient heat becomes liquid, and in its absence immediately congeals, or, in other words, again becomes rock.

Some rocks are liquefied by a lower degree of heat than others, and the species of rock of which the liquid termed water is the representative, is of all others the easiest melted. Aqueous rocks dissolve into liquid by any heat above 32°, while many other species of rock would require several hundred degrees of heat to melt them; but this is no reason why water should not be considered as a rock, or rather mineral, in a melted state, because it is the one upon the list which can be most easily liquefied. In most situations it is constantly in this state, but this is due to the atmosphere being generally of a degree of heat up to and above the melting point; and seeing it from our earliest years almost constantly as water, and not hard like other matter, is no reason why our prejudice should take it out of the category of rocks. All rocks melt, if not to water, into what may be its equivalent, by different degrees of heat according to their kind; water in this respect being simply at the bottom of the list. When the heat which melts any kind of material is absent, it immediately congeals again into its original hardness as rock—water in common with the rest—for when the heat which keeps it liquid is absent, or rather below 32°, like all the others —if it is fresh—it at once assumes the solidity of the rock, no doubt crystallised into the sheet of ice, and identical in appearance with the rough slab of glass melted out of the grains of sand.

The rocks, which are water in a melted state, may be termed aqueous; and from the time the earth began growing from an atom to the period we are dwelling upon, possibly about the same proportionate quantity of the aqueous material continued all along to make it up as land and water hold to each other at present. The aqueous material from the first would have remained evenly incorporated, and as solid as any other rocks throughout the body of the planet, but that—notwithstanding the absence of atmosphere—we suppose the body of the earth had then as well as now interior heat. How that heat is generated, whether by pressure or what other cause, we cannot determine.* Enough that heat was within the earth from the first. It melted the watery atoms from the others, the surplus naturally rising to the top from its much greater lightness, on the well-known principle that the heaviest sink to the bottom. And, as from the beginning, the melted watery atoms to a certain depth constantly continued to ooze up to the cold, where—through the absence of atmosphere there could be no heat—the water, thus melted with interior heat, rising near the surface congealed and formed an aqueous crust round the entire surface of the planet. Constantly increasing, it grew in thickness with its growth from age to age, until at the time of the visit of this its first atmosphere, we may reasonably suppose that thus far the universal icy covering of solidified water may have been hundreds of feet deep, of nearly an uniform thickness, not all pure aqueous rock, but we suppose considerably adulterated with new created matter, continually as at present falling in from without. Such was something like the condition we suppose the earth was in when visited by the first comet which bestowed upon it an atmosphere.

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* The heat, which is known to increase according to the depth we penetrate into the earth, cannot be connected with atmospheric heat. Heat, therefore, must have existed in the interior of the earth before it had an atmosphere. Geologists think that this internal heat gradually increases to the melting point, and that deeper down it greatly exceeds it, and the physical changes which have taken place upon the earth's surface go far to prove their theory. If such, however, be the condition of the interior of our globe, it must be accounted for otherwise than by the supposition that it at one time was a ball of fire.

The condition of snow at the poles and on the tops of the highest mountains in the world might throw some light upon the subject. In these positions it never melts, or rarely ever at the surface, consequently all the snow that has fallen on those inaccessible places since the beginning of the world, if it did not by some means or other melt, must, by the accumulations, be constantly raising their altitude. The secret is solved by the usual increase of heat, through a depth of matter, in these snow heaps the same as is universally experienced in penetrating deep enough into more solid matter. On the surface of the snow, elevated up above the clouds, it never melts. The cold there is intense above measure; but in sinking through, down to the rock, the principle of interior heat holds good, and that about the same according to depth as sinking into the crust of the earth. Thus as descent is made through the total depth of snow, the temperature rises until it at last reaches 32°, or the melting point, at the bottom of the snow on the surface of the rock. On all these Alpine peaks, at the rocks, the temperature is mild; and instead of being hard with frost, the deposits are soft with constant moisture. In short, the snow is for ever melting at the bottom as fast as it increases at the top, so that it can never rise above a certain depth, either here or at the poles, and all through the well-known principle of interior heat.

No sooner had the comet left the planet behind, than the new transparent covering its stronger attraction laid hold of in passing through begins to settle down, getting thinner and thinner upwards to its greatest height. This is a natural property of atmosphere, whether in a comet's tail or the covering of a planet; but why this wonderful medium sits down in such a state, instead of being equally compact like other material, is one of its many mysteries beyond our comprehension. It, however, very soon settled down into this its natural condition, and the immediate effects were grand and sudden. Previously no heat existed on the surface, and the aqueous crust continued, since the earth was an asteroid, undisturbed, but in the presence of atmosphere there was instant warmth round the whole globe. The heat, more especially within the tropics, caused the hills and hollows in common to melt with such effects as would be produced by the same degree of heat on the icefields at the pole. The rocks split up and commenced to rend with the voice of thunder, and the floods of the dissolving hills to rush along with fearful impulse. In a word the outer crust, formed for the most part of aqueous matter, is all soon melted into water, not the water of rivers or springs, but of a briny nature, which rushed on fearfully by its own gravitation until it found rest in the depressed places upon the planet's surface. Thus the great work of moulding the face of the globe into islands, continents, seas and oceans, took not a course of ages to accomplish, but was done as it were by enchantment, and reduced to harmony and perfection during a few diurnal turnings.

Out of the liquid of these melted briny rocks, now collected in the hollow places of the earth into seas and oceans, the atmosphere begins to draw water into itself in its perfect purity, free from saline atoms and all other rocky ingredients; and thus for the first time it returns back to the land in refreshing dews, or gentle showers from whence rivers begin to flow and springs to bubble up—the parents of fertility yet to come. By the enchanting wand of this new mantle of life, thrown over the world, the other elements are joined and work in harmony together. All is perfection for the support of animal and vegetable life, but there is nothing to live upon, and thus far there is no life. There is the light of the sun, air to breathe, heat to warm, rivers of purest crystal * flowing to the sea—meandering over the land with the rudiments of fertility in their bosoms; but amid this suddenly created elysium, in looking out, the world is yet cheerless to behold. All is desolation; nothing but naked rocks in their primal purity of colour, without even the relief of a rounded pebble or a grain of sand. But the rocks, being now for the first time corroded by the atmosphere and

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* As yet there were no grains of sand, mud, or vegetable decay, so that the rivers at first must have ran with the purest transparency.

beaten by the storm, in time dilapidate and decay, and their abrased particles gradually begin to fill up the surrounding crannies and lay the first deposits, containing some of the lowest elements of fertility. We say fertility; for although the first worn-off materials from the rocks were apparently perfect barrenness, still it was decay; and so sure as death proves life, so does decay, in whatever form, prove fertility in however low a degree. In these deposits of abrased rock there must, therefore, have been something of fertility out of which began vegetation of the very lowest order of nature—most likely microscopic, and in turn on the hoary rocks, now become venerable by the hand of time, crops of parasites begin. Nature having thus far advanced as to reach the lowest germs of vegetable life, their primeval decay, however little, added to the fertility that leaves food for somewhat higher grades of vegetable life; and in turn, by their decay, fermentation sets in. This creates garbage for the lowest insect life. Thus the development may be traced from its primal state, step by step; and, as fertility increases from the remains of the dead, higher types, both animal and vegetable came in succession, until at last, may be after the lapse of long weary ages, the earth by the increase of its fertility—which in reality means the accumulated remains of the dead—became prepared for the advent of man, appearing on the scene the highest development, the last of all, impressed with the divine image of his Creator, and as a link between death and immortality, appointed as lord of the world and all that it contains.

It may be said while reasoning thus, we are at an humble distance following the footsteps of Darwin; but while much may be said in favour of his teaching, we are far from admitting ourselves as his disciple. His doctrine of the grain of lichen-seed being carried hither upon a meteoric stone, and from it evolving after long ages, and during the lapse of millions of years, step by step up to the perfection of man, is perfectly fascinating. It has in it the ring of true philosophy, while it in no respect touches the attributes of Deity, for that mode of creation, in accordance with nature for the production of the races of the living, may have sprung from Infinite Wisdom; but with all its sublimity, fascination, and plausibility, the theory is not supported by an atom of direct proof in any department of creation. If evolution only meant the gradual improvement of each species of animals after their kind, it would be unassailable, as Nature cannot stand still. Everything, so long as it is in the direction of the useful, whether it may be man or other races, must progress. But when evolution means the improving of one species out of another—beginning with the crawling worm and ascending by imperceptible steps to man himself—we certainly require, besides philosophy, some hard facts to establish it; but there is not a single instance on record of any animal, or class of animals, changing in the least degree any of their features—changing into different breeds of the same species is another thing—either into a higher or lower order of being. Yet evolution, in the true and logical sense, is undoubtedly universal among them all, but it is not in the direction of the worm to the reptile, and through successive stages to the dog, the dog to the monkey, the final stage ending in the Godlike being man himself; nor in the gradual work of evolving superior races out of inferior, but in improving, as generations pass away, each species after its kind. Their bodies, their instincts, their animal propensities, are constantly improving, each race in its own direction, whether it be the feline, the canine, the bovine, the equine, or any other. All these improvements, instead of bringing them nearer, not only widen the gulf betwixt them and man, but likewise draw clearer marked lines in relation to the brute races themselves as compared with each other. Take that noble animal, the horse, as our example. He began after the flood small and stunted, and from then has been gradually evolved and improved into innumerable breeds, from the early antitype to the noble charger; and so far as he is improved, instead of being brought nearer, he is just in an equal degree removed from the nature of man. The same is more or less applicable to all the inferior races. As time progresses they continue to evolve into better dogs, better oxen, better horses, or whatever the species may be, and it is not preposterous to suppose that their evolutions will go on till in the end the ox and horse will become as large as the elephant, while the latter—should he not become extinct—may outrival the mastodon itself. This is the true evolution that is going on over the world, each species improving in the direction of its utility; but in the economy of nature, certain species growing larger, whether or not they will ever attain the size of the antediluvian monsters, it is unquestionable that it is only as to bulk they evolve. Like the grass they are made to perish, and can only be evolved to the useful purposes for which they were created. They only progress physically; for, strictly speaking, they are without mental powers, having only an inherited knowledge bestowed upon them by the Creator—in most cases limited to what is necessary to supply their wants and guard them from danger. Exception may be taken in a few instances, such as the dog and the horse, for they are often trained to additional intelligence, but only so far as to make them more useful to man. They cannot impart the scant knowledge they are taught to their offspring, so that as races of beings, in common with all the lower animals, the evolution and improvement that have happened to them from the beginning have only progressed bodily, while their intellects, or want of intellect, through all time remain the same.

How different it is with man, for he too is being evolved! Everything in nature, whether it may be life, animate or inanimate, mortal or immortal, must progress; but it is the soul of man which progresses and, in a physical sense, not his body.* At whatever period he first appeared—and his primal advent, as compared to the age of the world, was undoubtedly late—if we are to judge from his earliest remains found imbedded in the drift formations, these specimens prove his physical proportions to have been as near as possible the same as at present. Thus we have the clearest proof that his body, probably from his first advent upon the earth, has remained the same unchanged, and physically unchangeable. It is therefore the only part of him, the mind, or rather the immortal part, which continues to be evolved; and that evolution amongst the civilised races has continued, at least in some parts of the world, since the Deluge, and has raised him step by step higher from the lowest barbaric condition up to the level of the Briton. It is not the body of man, but the germ within that is of value; this continues evolving to loftier heights, and as the ages roll away it will gradually rise to more angelic perfection.

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* There is this marked difference betwixt man and the lower animals, that the latter continually improve as their generations follow; but man being a

With these feeble remarks on what we think of evolution, resuming our subject, we may reasonably suppose that, when by the lapse of time the new atmosphere produced fertility to give life to the lowest germs of vegetation, in the course of nature crawling things followed, when there was garbage to feed upon. This beginning of life by slow degrees gradually prepared the way for higher types of existence. Insect life followed, and there were birds to feed upon them, grass and herbage began to grow, and beasts—at first extremely diminutive—sprung up to browse upon them, and simultaneously with these, others to run them down as their prey lest they should multiply beyond measure, and, for want of plenty, starve and deteriorate. Thus in progress of time one race of animals did not replace but succeeded others of a lower type, all appearing in their proper times to fill up the gaps in creation allotted to them, when once the earth became so far matured as to produce sufficient for their support.

As these conditions continued to be fulfilled, all the races of beings undoubtedly one after the other appeared on the scene; but how or under what circumstances Nature in the past, and we might almost venture to say in the present, gave existence to the different species of animals, just at the times they were wanted and when enough was provided, is a mystery; with our present state of knowledge it would be presumption to decide, the philosophy of evolution notwithstanding. Yet wherever there is sustenance there is life, either animate or inanimate. Nevertheless, nature is antagonistic to one species amalgamating or advancing out of themselves into the higher status of another, and by such steps rising up to the level of man. The more rational view, and the one in accord with universal experience during the

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responsible being, his progression depends upon his free will. This accounts for the greater portion of the human race—in regard to breadth of territory—still being in their primitive condition. They have no will to improve, while superior races have the will; hence the marked contrast in their conditions.

historic period, is that the millions of species existing over the globe were all from the first, in every essential, the same, but in the case of the larger animals since their primal existence vastly improved, physically; for it is characteristic of many of the lower races, that as their generations follow, their size and proportions slowly but constantly increase. It is, therefore, reasonable to conclude, that they may at the first have been very diminutive; time and the operations at work, which universally evolve in the direction of the useful, having gradually invested them with their present stately forms, without changing in the least degree their character or habits as species, or raising their mental inferiority. The condition of humanity is just the reverse. How man first came into the world, it is impossible to determine; but, as already observed, wherever we find his remains in the deposits of the earth they prove him to be the same perfect being, physically, through the ages he has existed as he is at present; but unlike the beasts that perish, his mind, the immortal spark within him, rises higher, as the world grows older, and it would be as absurd to say that human advancement will find limits, as that perfection itself could be reached.

After all, it is only human weakness to pry into the mysteries of Creative Wisdom by philosophising upon recondite subjects, of which we must be profoundly ignorant. But should science ever reveal to us the natural laws which first peopled the earth, however mysterious, we will discover Almighty Design in all the operations which are gradually adding beauty to the world and bringing all things to greater perfection. These operations of nature still continue to produce all beings that exist, but how or why they begin and live or exist just when the earth becomes a suitable abode, and at the right times in the economy of nature they are needful, is beyond human comprehension; yet if the causes could be traced, instead of chance, we would perceive Infinite Design. Whenever our knowledge reaches the cause or causes on any subject in nature, we discover behind Intelligence and Design producing results, by laws sublimely simple, and for this very reason they remain mysteries for ages, above the reach of weak mortals to conceive.

A numerous school of scientists would have us believe that all such wonderful effects—by some incomprehensible process they make no attempt to explain—were the results of blind chance. The heavens and the earth, the sun and stars, the air we breathe, the light and heat we enjoy, our living organisms and sublime mental conceptions, all, all are chance! The worlds themselves have been produced from atoms by the fecundity of space, and, according to their light, that may be chance; but the atoms as they continued from age to age to generate would have hung in a state of inertia, filling the abyss of space as a luminous vapour; but He Who bestowed natural laws for the production of these atoms endowed them with attraction, the primal agent for collecting them together into worlds. Surely this is Almighty Design, and not chance! Another Divine emanation is light. When the worlds were formed they were in the midst of light; not one was in darkness, for, like attraction, light emanates from all matter; hence this element is universal wherever creation exists—another wonderful proof of Divine Intelligence. The worlds being now made up, and preserved by attraction, with light to illuminate them, yet with all these glorious and indispensable attributes they would still be useless for the purposes they were created; but prescience again manifests itself, in the creation of majestic comets—by Almighty Design—constituted to claim the entire universe as their system. Thus in due time, through their wandering propensities, they were enabled to bestow the elements of life on virgin worlds, or to give renovation to old worlds become effete with age. The planets being made to move on circles and thus held within proper bounds, the harmony of the universe is preserved, and life given to it and harmony made more perfect by comets taking a wider range, meandering at will unchecked, wherever material forces lead them. If they were held bound within systems, the greater portion of creation would be void of life; for few worlds matured to habitable size would have any chance of being clothed with atmosphere, as the comets would all be permanently held within the systems of the great suns, deserted spots in space within which few worlds exist. If we want to find a multiplicity of habitable worlds, we must in imagination wander into the telescopic regions, which practically take up the whole of the universe, for the odd spots rendered nearly bare by the action of the great suns are, in the aggregate, infinitesimal by comparison. If space in these regions is equally prolific in the generation of matter—a very reasonable inference—a scenery of worlds, such as we formerly depicted, more or less modified according to circumstances, unquestionably exists, and it is therefore through these interminable regions the wonderful uses of comets must have their fullest effects. Here within our system habitable worlds are so few, that during the period of human history there is not a single instance known of any one of them having passed through a comet. But when a comet shifts out of our system amongst the telescopic suns, it is surrounded with planets as thick as stars, thus, as one of the heralds of life, it is enabled to perform as much more good as worlds are numerous. The man or class of men who can see in these wonderful plans, so harmoniously worked out by material causes, only blind chance, have a philosophy we by no means envy; and, however unfashionable the expression may be in a work of science, we unhesitatingly pronounce that these wonderful material operations prove the prescience of their Almighty Author, through and by whom all things exist—a Being so infinitely above our comprehension, that the idea of His presence filling the universe is in no respect too high a conception of His greatness.

CHAPTER XVII.

DISTRIBUTION OF ATMOSPHERE.

No worlds are habitable except they have borrowed atmospheres from comets. Some odd ones have never passed through such an ordeal, and are still in the cold desolation of their virgin state, without life, while there are many others of very small magnitude covered with atmospheres so thin as to have no life upon them for the want of sufficient heat; and lastly, there are others—very large bodies—that can never borrow atmospheres, by reason that comets cannot move right on them. Three out of the four major planets fulfil these latter conditions—viz., Saturn, Uranus, and Neptune. They therefore can never be swept by comets; for their distance from the sun gives them, respectively, spheres of attraction so wide that when these erratic visitors approach them, they are held within their precincts as governed bodies; and it need scarcely be repeated that a subjected body can never fall upon one which governs it. When a comet, therefore, approaches any one of these three great planets, and once fairly within its grasp, it is deflected in a certain direction round it by the action of its rotatory motion on an orbit, so far as it can be described, of a shape in accordance with that natural to it as a comet, and it very soon escapes out again under the direct government of the sun. The fourth, Jupiter, is the largest of these major planets, but being nearest the sun, his sphere of attraction is so much more circumscribed than those of the others, that it is doubtful whether it may be entirely free from the ordeal, at extremely long intervals, of passing at least through some of the largest comets, should their motions lead them direct on to it. We have the instance of Lexell's comet being caught, and for a very short time governed, by the planet; but the comet in question was not by comparison one of the largest class, so that it is still questionable whether his attractive sphere is wide enough to give him a governing hold of the greatest comets which sometimes appear. If so, we may then conclude that not one of the four major planets can ever be enveloped by a comet. Nevertheless, it is most likely that the three nearest the sun have each one its atmosphere, for they have in the early periods of creation been all partially made up by the incorporation of small bodies, each one having been liable to bring with it a certain moiety of atmosphere when incorporated.

The sun, unlike the great planets, had no source from whence to borrow an atmosphere, for no planetoids or other larger collections of matter can ever fall into him, as a share of creation. His whole composition from the beginning has been made up of aerolites and minuter matter, down to invisible atoms, and such a class of objects can bring no moieties of atmosphere with them in being incorporated with the great body; for even if any of them, in their descent to the sun, might chance to pass through comets, the force of their sweep would scatter their incoherent materials into their original vapour. The sun, therefore, could not possibly have received an atom of atmosphere from any of the incorporated materials that during the creative period up to the present have raised him to his enormous size. It is equally certain that the medium could not have been directly bestowed upon him by comets themselves; for while they are within his precincts they submit to his government, a condition which in all cases, whether in connection with planets or suns, must keep them free from contact. No body that is under the government of another can ever fall into it: the sun could thus have got no atmosphere direct from comets—no atmosphere could have come in along with the materials which from the beginning have made him up; he is therefore, instead of being a ball of fire, a body—for want of atmosphere—of cold, dry, boundless desolation, without a thing of life over his vast surface.

The system thus viewed broadly as a whole, bearing in mind the antiquity of creation, we may reasonably conclude that except the sun, atmospheres are common—Neptune may be an exception—to most of the leading planets, and that three out of the four major planets have borrowed their atmospheres indirectly from the small bodies, which through the course of time fell into them and in great measure made them up, and that all the minor planets, enveloped in these mediums, have borrowed them direct from the comets themselves, which at various periods of their history, they have chanced to pass through—each one when inside the comet having held fast a quantity of the atmospheric material proportionate to the force of its attraction. It therefore follows that the earth, being the largest minor planet, has surrounding it a greater bulk and depth of atmosphere than any of the others, and that in relation to each one it becomes less and less in the descending scale as the bodies are smaller. This might be disastrous to the latter, were it not that the wonderful properties of atmosphere—in so many respects dissimilar to all other matter—meet the shortcoming, and in regard to heat places them all—not below a certain magnitude—on an equality. The earth, for instance, which no man from his present knowledge can pronounce its exact depth—may have surrounding it a stratum of atmosphere forty miles thick, while another planet much smaller, say about the size of a small lunar body, had only power to withdraw from its comet two miles thick of the medium; yet from the manner it in all situations settles down—attaining the required density at the surface, where heat is only required for the support of life, and becoming, as it always does, thinner to the top—it can be of little consequence whether the depth may be more or less. Whatever may be the depth of the atmospheric covering—and it always must have a depth in proportion to the magnitude of the body it covers—be it one mile, ten, or a hundred, we suppose it sits down on any body not below a certain size, equally condensed at the surface, and thus there is by the action of light generated in it the same degree of heat, notwithstanding its gradual attenuation to nothing over so small bodies at a much lower altitude. But these conditions, as they are based on the force of attraction being enabled to wrest from comets their atmospheric coverings, would be too light to fulfil the requirement of imparting life-giving heat, if the bodies were of too low a magnitude! Beginning, for instance, with planetoids up to low-sized asteroids, when they chance to encounter comets, their inherent attraction, in keeping their materials together, is so weak that we may take it for granted that—after the manner of aerolites in our atmosphere—the cometic forces at once sweep them into their original atomic vapour over space, to be gradually absorbed into the sun. Again, there is a higher class, the next step below lunar bodies,* that have inherent strength within them to withstand, without being dissolved, the shocks of transits through comets, yet they would withdraw atmospheric coverings so very thin as to be inadequate to produce heat that would liquefy their aqueous crusts into water. In the cases of these small bodies, therefore, there may be atmospheres on many of them; but being too weak to produce water as one of the elements of life, of course upon them there can be no life. Rings are another class of bodies we must consider. These appendages of Saturn have a greater surface of dry land than perhaps all the planetary bodies in the system taken together; if they, therefore, enjoy sufficient atmospheric heat, and there is enough evaporation from the very small patches of water which must be on them, the swarms of life over their endless plains must be wonderful. But there are reasons to believe that, if they have atmospheres, they are too thin to give life. In the first place, they are too near the planet to have been swept over by any comets in the past that may have been entangled under its short-lived government, so that these annular bodies, if they have atmospheres, could not have received them direct from comets themselves. Any atmospheric material they possess, must be traced to the original bodies out of whose shot-out materials they were formed. These latter, when planets, may, and most likely had atmospheres of their own ; but we must consider that their materials when spread out assumed, when reconsolidated, a shape with a proportionate surface a hundred times larger: hence, even assuming that such light material as atmosphere was spread out with the other grosser materials in common, the covering would be so scant as to produce no requisite degree of heat for the support of life.

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* We suppose our moon, if within a comet, to be sufficiently large by the force of her attraction to carry with her, after the ordeal, an adequate depth of atmosphere that would impart heat which would reduce her aqueous rocks to water, and thus bestow life upon her; but we have only to look upon her to be certain that none of these effects are produced. We are therefore justified in supposing she may be one of the very rare instances of minor planets which have never passed through comets. If this is so, she cannot have even the most attenuated covering of atmosphere, and must still be, as we described the earth once to have been, in her primal virgin state of cold desolation.

Supposing all the foregoing observations on the distribution of atmosphere to be true, or near the truth, the sun can be pronounced as a body without life, by reason that there are no natural operations at work or ever have been that could have given him an atmosphere. The rings of Saturn, and the small fry of worlds below lunar magnitude, have likewise no life, because their scanty atmospheres lack the degree of heat that can produce water, one of the indispensable elements of life. Lastly, all planets without exception—which from the nature of the question must be very few in comparison—are without life that have never yet received an atmosphere, whose lot it has been from age to age not to have met comets in their tracks, and consequently are still deprived of that medium which has been created apart to bestow life to the universe. All other bodies, without exception, have their atmospheres, and without doubt many of them are abodes of life, consisting of types of higher or lower orders of being, according to their advanced conditions.

Here we may be brought to task, for such broad conclusions as to other planets being inhabited without a shadow of proof to support it. Let us, however, observe, if sailing in a gentle clime with a newly-discovered sea-coast in the distance, the man who would report the new land to be inhabited, purely by analogical reasoning, would be universally credited, although not a living being could be seen, and no one would doubt of people being there. But what would we think of another passenger-observer, on his return, solemnly publishing to the world that the newly-discovered land was without inhabitants, having no other proof than that he could only discern the outlines of its blue hills. Whatever credit might be given to his honesty, his judgment, after the perusal of such a document, would be very lightly esteemed. The reasoning would be equally shallow, even to doubt that any of the distant worlds are without life, if fully endowed with the elements of life. In all created bodies, whereon the elements of life exist in full perfection, land, water, light, and atmosphere, living beings must exist. In some bodies, no doubt, life upon them is of a low order; in others of a higher and higher type, till we can rationally conceive of worlds which have gone uninterruptedly through immense periods of time in civilised progress, and thus their inhabitants may have reached a state of mental advance far above what we can have any conception of.

We may now direct our attention to the bodies within our system, which have got life-giving atmospheres, and ask, Have they all living beings? Our unhesitating reply would be, Yes; Are they all peopled with intelligence? Our answer should be that it would be extremely hazardous to say that, besides the earth, a single one of them is; but that there are three others that might be the abodes of intelligence of a higher or lower order according to their state of advancement. Even the earth itself was not favoured as a seat of rationality until a time very recent compared to its age; and the others may be still in their nonage, the same as it was heretofore. Again, turning our attention to bodies of recent formation, born only to add to the fabric of others and to the lowest class of lunar bodies—although the antiquity of the latter stands high—we suppose that all such are without inhabitants, for they cannot have atmospheres sufficiently dense to support life. The three nearest major planets most likely have atmospheres and life upon them, but we imagine, whatever they may be, very few beings upon them rise up to the rational standard. We don't pronounce these great bodies unfit for human abode by reason of the strong attraction—which, judging from their magnitudes, might possibly press terrestrial beings to death—for in such cases nature would be sure to bestow organism in harmony with the surrounding forces of attraction; but for another reason, that it is likely there is scarcely any dry land to tread upon on these overgrown bodies. Thus, if there is an atom of truth in what we have already advanced on the formation of bodies, every one within our system, the sun included, is made up of the same kind of materials, each one having an equal proportion of water, together with all other increments that make up their respective bulks. On this assumption, as the surplus water on any globe must be on its surface, it being the lightest, it follows that, according to the greater size of a body, the entire surface to the whole bears in the same degree a lower proportion. As therefore the body from age to age increases in magnitude, the waters in the same degree encroach upon the land; or, in other words, after a world attains a certain magnitude, as it continues to grow larger, its dry land lessens. It is thus easy to perceive that from the enormous magnitudes of these bodies—more especially the two nearest—there are but few spots of dry land left over their surfaces. They are most likely covered with fathomless oceans literally without a shore; hence on them there cannot be any appreciable extent of land for the abode of man or beings endowed with rationality, however thickly their waters may be tenanted by creatures of the deep.

Having thus cursorily glanced at the various classes of bodies within the system, if our basis is truth, we can dismiss the numerous little worlds which are known to exist—the most of them as being unfit for life of any description, a few others on which a very low order of life might exist, but likely not one of them fit abodes for rational beings. We might also include most of the lunar bodies in this list; but we cannot well do so, as some of them, if not all, are of the requisite magnitude, and no doubt they are perhaps all of ancient date—still we repeat, if they are to be included, there are no other bodies within the system on which man could comfortably exist except the four minor planets, Mars, Earth, Venus, and Mercury. According to our finite notions, bodies of this class and stamp meet in a more perfect manner the requirements of both rational and irrational beings than any others of higher or lower magnitude, and we suppose that primary planets of this order are a hundred-fold more numerous in the telescopic regions than in our system. Of these four planets we are so much attached to, there is very strong reason to believe that at least two out of the other three have their atmospheres, and if so, they must be the happy abodes of myriads of living things such as we see on the earth around us. It might be that they have reached a higher condition than that of the earth—for we are to bear in mind that terrestrial civilisation began only at a recent date,—or possibly they may be in a more primitive condition, all depending in some measure on the period or periods when atmosphere first utilised upon them the elements of life.

When atmosphere first covered these as well as all other bodies of a certain magnitude, the degree of heat imparted to one and all was about equal; for in studying the economy of the heavens we must bear in mind that the heat is not from the sun but in the atmosphere itself. Like fuel that has fire dormant within it, a spark gives it life; in like manner, the heat is in the atmosphere, and the light of the sun is the spark that kindles it into higher life. The operation of light on the atmosphere is in itself the clearest proof that none of the heat produced comes from the sun. Thus, as has been elsewhere observed, the greatest possible heat is produced by the light descending vertically on the atmosphere, and it decreases according to the greater angle of its declination, till at the rising and setting of the sun there is no heat produced; whereas, if the heat descended from the sun as a ball of fire it would be equal throughout the day, and not a shade of difference would be in its intensity either at noon or at the rising and setting.

So much for the idea of heat coming from the sun; but we confess it is not so easy to give direct proof that a body would enjoy the same degree of heat, whatever distance within the system it might be—the only direct facts to confirm it being the comparison of the seasons of the two hemispheres, and the existence of oceans on Mars. So far as these facts go they are very conclusive, but not general enough to be a finality. We will, however, put the question on the broad and unassailable basis, that everything which God has made is perfection itself for the purposes it was created; but the state of the universe would be for the most part desolation, if the heat enjoyed by the planets depended upon distance from their suns. In every system there would exist only one planet on which life could be enjoyed. Our earth is the lucky one within our solar precincts. How happily chance has placed it, so as to be blessed with the exact measure of heat that is wanted; so beautifully near the mark, that our condition would be in the same degree more miserable if we had been nearer or more remote from the sun! What reason have we to be grateful that it is not our lot to be in any one of the latitudes of the sister planets, Mars or Venus; for in either position, if heat is according to distance from the sun, we could not have existed subject to the scorching heat of the one or frigid cold of the other. Extending our views right and left yet another step, our selfish gratification would be still more flattered by reflecting that on Mercury if the rocks do not melt, at the very least every other material is burnt up, while on the planet Jupiter there can be no heat, with the comforting assurance that living things could not exist either on this body or any others which lie beyond. Such are the only conclusions that follow the philosophy of heat being according to distance from the sun, and if true, there would be a gap of imperfection in creation so wide as to leave nine-tenths of the universe a desolation. We cannot, however, believe that creation is so imperfect, that through either an excess or defect in heat it is nearly all a waste; but on the contrary—although the idea is opposed to the whole of mankind, and admits of very little direct proof—we think, without the shadow of doubt, that distance from the sun has no effect whatever in the degree of heat any planet enjoys, and that wherever a body may be, in any position of the universe, if it has an atmosphere the heat upon it is still the same in all situations. Light is the agent that awakens the heat simply by its presence in atmosphere, and not the degree of its intensity, and as an element indispensable for the generation of higher heat than is natural to atmosphere it can never be absent, for where matter is there must be light, and if a body shines not itself it is at least shone upon.

CHAPTER XVIII.

VARIETIES OF ATMOSPHERE.

In a former chapter we referred to the different appearances of comets, some being brightly silvered over, others less and less so, down to invisibility. We put down the bright coloured ones as being composed of the grossest atmospheric material, and that all others, according as they are fainter in colour and outlines, we supposed were made up of materials in the same degree purer, till we reached perfect purity in those which are wholly invisible except their nuclei. If these ideas are true — but which, in the absence of any direct proof, must be put down as purely hypothetical —it follows that there may be many varieties of atmosphere, some more pure and others less so, according to the nature of the comets they may have been drawn from; and as atmosphere at the same time gives life and death, life in any particular planet may possibly be long or short according to the purity of the atmosphere inhaled. The atmosphere to which we owe existence is to us perfection itself, because we have no other atmospheres better or worse to compare with; but after all, we imagine the earth is rather unfortunate in its present atmosphere, for it has inherent defects we will presently see the atmospheres of some other planets are likely free from. One of the characteristics of our atmosphere is that it is changeable in the extreme. At one time we have calms, at other times hurricanes, tempests, and tornadoes; sometimes we are deluged with rains, and at other times the land is parched with drought. It is likewise uncertain and fitful in the blessings it confers on one part of the world compared to another. Here in the United Kingdom the rains descend with such regularity, that on the average of years the husbandman can depend on a return in due season more or less prolific, and the same may be said in favour of many other parts of the world. But in more than half the globe, and in that by nature the most fertile, crops are sown with doubtful hopes of being reaped, for they very often perish for want of moisture; while, again, there are other wide tracts, especially situated in the temperate zones, or rather what is understood as semi-tropical latitudes, rendered at least for agricultural purposes literally deserts, all for the want of the frequent recurring showers that give fertility and make the earth glad.

Such are a few of the leading defects of the atmosphere under which we are placed, and taken as a whole it would not be irrational to suppose that there may be atmospheres on other planets free from some of the defects mentioned. Other planetary atmospheres may also have unknown defects, so that it is impossible, on a subject on which we can have no direct evidence, to pronounce our atmosphere inferior as compared to others. Still, the absence of the defects natural to it would give us a better article as a substitute, and looking in this light upon the subject, we are led to suppose that the last comet which gave us an atmosphere—for we cannot help thinking that every time a planet passes through a comet the old atmosphere is carried away and a new one as part of the comet left to replace it—must have been of the grosser description, fit, as all atmospheres are, to give and support life, but so imperfectly as not only to cause the many vicissitudes mentioned, but in a material degree to shorten the span of life. Who knows but if it had been our good fortune to have drawn our atmosphere from one of those comets, so pure as to be invisible, that under its serene influence human life might have been nearly a thousand years, such, as Hebrew tradition informs us, the antediluvians lived; and as they were likely in the Adamic era under a different atmosphere from the present, the account, after all, is not to be dismissed as purely mythical.

These reflections should be justly put down as idle dreams, were it not that we have some evidence that our sister planets, Mars and Venus,[*] have each their atmospheres, and in both they appear to act quite differently from the fickleness of our terrestrial atmosphere. They have their outlines proportioned fairly into brighter and darker grounds, reasonable proofs that the divisions are oceans and continents,* and if seas exist no possible evidence could be clearer than that they have atmospheres, for where there is no atmosphere there can be no heat, and without heat there can be no water. Nor can there be much doubt of the grand divisions, which their surfaces present to us, being land and water, for at such a distance, if the bodies themselves were all dry land—which they must be if they have no atmospheres—they would be of a uniform colour all over of the brightest white. In short, planets so comparatively near as these two, when in conjunction with the earth—especially Mars, which faces us with its full disc enlightened—as they show themselves so plainly in map-like divisions, cannot be looked on in any other light than as bodies divided into oceans and continents. Once granted that they have oceans, or any liquid element whatever, it as clearly proves that they have atmospheres as if we were privileged to inhale them, for where there is water there must be atmosphere. Both elements in every habitable world must coexist: where one is absent the other cannot be.

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[*] If we exclude Saturn, it is probable four of the primaries have atmospheres, the earth, Jupiter, Mars, and Venus; and judging from the apparent effects produced, all their atmospheres essentially differ from each other.

The atmosphere of Venus is transparent and without clouds, while that of Mars has a ruddy tinge; but we suppose it also is cloudless. If neither of these planets have clouds they can have no rains, and thus their lands are moistened by the natural and more perfect process of constant dews.

As regards the earth and Jupiter, both their atmospheres are cloudy, so that rain is their principal fertiliser; but there is this contrast betwixt them, that it is probable the seasons of the one are certain, but on the earth fitful uncertainty is the true characteristic of its rains and atmosphere. The parallel belts of Jupiter are its clouds; they periodically shift their positions, thus proving an unchangeable regularity in its climate. On our earth there is always about the same proportion of cloud vapour as the belts of Jupiter present; but it is irregularity subdivided and mottled over nearly all its surface, and in nearly all positions quickly evanescent. To one sitting on the moon, the changing aspect of a world half covered with silvered spots, continually vanishing and reappearing, would betoken to him some unknown perturbation in nature, which sad terrestrial experience tells us is the constant changes of our uncertain clime.

Of the atmospheres of the four planets, judging from appearances, that of Venus is the purest, and from its tinge of colour the atmosphere of Mars must be looked upon as inferior; but if it returns all its moisture in dews it is superior to that of Jupiter, which being cloudy, must be a rainy atmosphere. But his parallel belts periodically shifting their position, prove the rains to be regular, and in this respect that his climate, in turn, is superior to that of the earth. The climate of the earth is all fitful uncertainty, and judging all the known circumstances, the most inferior atmosphere of the four planets is the one we inhale.

That Mars has an atmosphere is generally admitted by the learned, their conclusions resting on the ruddy colour of the planet—most likely owing to a comet of the same colour. We are curious to know if there are any comets in the astronomical register tinged with a reddish colour. In colour at least the atmosphere of Venus instead of being ruddy is, as far as we can judge, purely transparent, consequently in this respect the atmospheres of both the planets are the very opposite, but in one important particular they are similar. On both, as far as we can discern, neither clouds nor rain are produced. This broad conclusion is arrived at simply by our organs of vision. If clouds and rain existed upon them, the former would be visible—not the passing cloud-patches with which we are familiar in a broken sky, but such collections of cloud-vapour as frequently lie at the same time over different parts of the earth, indiscriminately veiling it ler an unbroken sheet, without a break, as wide and often ch wider than the expanse of the United Kingdom. If such uds exist on these planets over their oceans,* they would be the power of the telescope as plainly visible as the island of eat Britain to the naked eye in the map of a school book. e total absence, therefore, of such bright evanescent spots over ir oceans is a very strong reason for concluding that their ppy climes are neither troubled with clouds, rain, thunder and npests, nor any of the fitful changes which render half the earth ruitful, and bring on its inhabitants so many discomforts and ast amount of misery.

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* The disc view of Venus shows the smallest proportion of her surface to be sea, thus the order of the two, as compared to the earth, being reversed. In meeting this question it may be in the first place observed that it is impossible, as both bodies—in common with the others in the system—have been made up from the same source, that one can have a greater appreciable proportionate share of water than the other. However, astronomers affirm that the mountains or rather the dry land of Venus is of extraordinary elevation, and if so, her oceans may be equally deep. This would at once account for the contracted expansion of her oceans, for the shallower the oceans of a planet are, they in the same degree usurp a greater portion of its surface. Considering the size of our own globe, its oceans are extremely shallow, hence more than two-thirds of its surface is covered by the overflow; but if our oceans averaged thrice their actual depth—which would be very shallow compared to the ball itself—they would only take up one-third the room they actually hold, and thus leave the grand surface proportions, as is the condition of Venus, dry land instead of water.

f we were asked to describe the climes of Mars and Venus, our ly, of course, would be that on such a subject, from our prond ignorance, it would be presumption to decide, but in fancy might portray them as follows: Let us first take for granted, at we have little doubt of, that both are invested with atmosphere, l with it the inevitable accompaniments, oceans, and in the oyment of heat equal to that on the earth. The heat produces poration the same as with us; but here it returns to us, part in v and part in rain. Thus a radical weakness in our atmosphere its attempt to act in the perfect manner of bringing back the porated atoms in dew, but this important and vital function it only strength to do in part. A small moiety only descends in v, the rest, the greater proportion, hangs up, and like unhealthy nours bursts out in fits of unnatural deluges of rain, frequently ompanied with thunder and tempest, and the recurrences being ertain, droughts are common, and the world is thus robbed of east half its productiveness, and a large portion of it turned o irreclaimable desert. It seems to be altogether different with other two planets, for without clouds they can have no rain or npests, and the greatest commotions of their atmospheres are st likely gentle balmy breezes. The evaporation of their days olly descends in the coolness of their nights, so that in this important respect their atmospheres perform their proper ctions. This return of the total evaporated water continues hanged through all seasons; but in winter there is less heat, s evaporation, and less dew, and in an exactly equal degree the isture is less wanted, while in summer there is greater evapoion, but only equal to the greater demand of the season: thus all seasons the supply just meets natural requirements, neither re nor less. The total evaporation of each day falls during the ht in about equal proportion, taking the year round, as the vs and rains united which moisten the earth; but it descends about equal quantity from night to night throughout the year ording to the season, just fit to keep up the highest possible ility, the surplus either descending into the rocks to feed springs t never dry, or gently trickles into rivers which run into the

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We suppose the evanescent vapour of clouds would not be visible over the l, as the light reflects the same colour upon them as the dry land presents.

ocean like terrestrial streams, but they never overflow or dry up. The husbandman sows without anxiety, for the elements are so certain and unchangeable that he can foretell to a handful what will be his returns. He undergoes no hardships in reclaiming barrenness, for the kindly atmosphere, with its continued dews, has made all the dry land a smiling garden, every spot clothed with exuberant fertility, with the exception of the tops of the mountains and the frozen poles.

Such is a feeble description of what may be the climatic conditions of Mars and Venus, and our condition on earth might have been equally favoured if it had only an atmosphere free from the many defects referred to. On the other hand, if we had enjoyed a paradise of abundance, such as we have described—and which we suppose was the condition of the earth during the Adamic era—there would have been no inducement to exertion; and as is the case already in some of the rich localities of the luxuriant tropics, man, at least such a race of men as inhabit our planet, would have for ever stood still. Nature would have showered into his lap plenty in return for little labour, and it is more than likely, being thus without a stimulus to his invention, instead of advancing he would still be in his primitive state of savage indolence; for it seems to be a universal weakness in our planetary race to stand still and make no progress except from necessity, want, or the prospect of want. Such incentives applied—more especially to the higher races of mankind—spur them on, and thus in the main we have risen up step by step to our present level from no higher motives, while it is possible that some other planetary races may be morally constituted in such a higher degree, that although luxuriating in paradises of plenty, they continually rise mentally higher in the direction of that perfection which borders on the everlasting.

Planets are always subject to the contact of comets, whether in a virgin state or as bodies already clothed with atmosphere. And such are the chances which they run, if of a certain magnitude, of being hit by these erratic wanderers which visit our system—each one has a remote liability of passing through it, if it only happens to be in the track of its sweeping motion. There is one consolation in knowing that events of the kind may not happen to any particular planet during an immense period of time. Still these ordeals are sure to be repeated at longer or shorter intervals on some, if not on most planets of ordinary magnitude, and when they do occur on any one body the effects produced, on account of the living beings upon it, must of course, be very different compared with what happened when it first borrowed its transparent medium. By their primal contacts, comets, for instance, bestow upon the planets their first elements of life, and in due time, living things follow; but in their subsequent transits they have their old atmospheres carried off and replaced by new ones, and a large proportion of the living destroyed. The change renovates a world; literally old things pass away and "all things become new."

Under a new atmosphere, it may be the fortune of the future race to have their lives prolonged to a thousand years, and their dry land, hitherto during the preceding epoch generally barren, to become in the highest degree universally fertile; or, *vice versa*, from its gross and inhospitable nature it may give an unkindly and sterile soil, and wither life down below a hundred years, as is the case at present in our grovelling and selfish world. We use these terms deliberately. Human progress must be very low in our planet when its inhabitants, no matter of what kindred or tongue, are, generally speaking, incapable of rising except from animal necessity; their inhospitable clime is therefore the most suitable to impel them on eventually to a higher condition.

But, whether or not, the renovation of a world be a better or worse condition imposed upon it, the grand ordeal must be in a greater or less degree fatal to many of its larger inhabitants, but in every case the proportion of fatality must greatly depend on the conditions of the transit. If the transit would take place through the end of the comet's tail—the part where its matter is most attenuated—there might be a great commotion, but we suppose unattended with many disastrous effects; but if it passed through any other part of the comet—we are speaking of broadside transits—the sweeping shock would be more or less severe, according as it might take place near or more remote from the nucleus. We suppose atmospheric density increases every step in that direction, in the worst cases therefore it may be that forests would be swept away, human habitations scattered as dust, and a very great proportion of the largest animals destroyed. Again, if the transit happened through the nucleus, everything alive on the dry land would be burnt to cinders—that is, if the nuclei of comets are huge gas flames, an idea we have mooted elsewhere; but as few facts except naked appearances, always deceptive, bear it out, we avoid the responsibility of advancing it as a truth. Lastly, if the planet passed through the comet end on,—for the uncertain motions of comets render them liable to fall upon planets under any of the supposed conditions,—although it would not be so universally fatal to life as its baptism in fire, the physical effects and changes produced would be far greater. These transits end on, from the conditions in relation to such events, cannot be very frequent, but when such a transit does happen, the planet must of course pass through the comet lengthways, or nearly so, suffering from its raking force—beginning from the attenuated matter at the end of the tail for nearly the whole distance, through all the degrees of its density, for perhaps no less than a hundred million miles. This gives time for the comet, whatever may be its velocity of motion, to raise up from their lowest depths and drive bodily before it the oceans in bulk over the land. The inevitable consequences follow—this most disastrous species of transit overwhelms the entire planet with its oceans, and drowns its inhabitants. Such a calamity befel our planet only a few thousand years ago.

If comets are bodies of atmosphere, the foregoing results, or others not dissimilar, must happen when planets pass through them, and that these cometary epochs are liable to be repeated at long intervals without end, is a truth resting on so sound a basis as not to be gainsaid. Most likely it is to fulfil the purposes of Creative Wisdom that such calamities recur upon habitable worlds; but it is beyond our comprehension why they are all liable to pass through these terrible ordeals, which in each case must sweep off most of their inhabitants. Taking another view of it, we know that a new atmosphere is the renovation of a world, and it is possible these changes recur as a necessity for the continued existence of the races of beings themselves which people the different planets. Atmosphere, as an element of life, through being breathed for long ages may deteriorate, and thus nature from time to time renews it, so as to continue the races of the living through all time.

That broader views may be had on these and such like changes, we may observe that there are two classes of epochs that at least our earth passes through, and most likely many other planets,—namely, cometary and geological epochs. Except when a general deluge is the result, which in the great majority of transits cannot be, cometary epochs leave very few lasting records behind them; but the effects produce in the initial step a vast destruction of life, with the bestowal of a new atmosphere, leading to a new order of things, universal and equal over the entire surface of the planet. On the other hand, when a geological change takes place, the effects produced, whatever may be their extent, are local, and we suppose never changes the face of the globe universally at the same time.

Thus, to give an idea of a great geological change, it might happen that a new continent would be upheaved from the bottom of the Pacific adjoining the South American continent, which we suppose is the oldest land on the earth. At the moment of upheaval —perhaps produced by the explosion of internal gases—a vast empty void would be hollowed underneath the raised-up crust, which would by its own weight necessarily sink back to its former level under the sea; but at the instant the new land is raised, oceans of the liquid rocks of which it is supposed the interior of the earth is composed, rush in by their own gravity and fill the cavity as soon as it is made. This gives the new continent, or whatever less of expanse it may be, a foundation of permanent rest. In the meantime, the burning liquid that from every side rushes in to prop up the raised-up land, at its new elevation above the waters, leaves another empty void under the venerable land adjoining, which by its weight at once drops down to the bottom of the yawning vacancy underneath, and thus, in its turn, becomes once more covered with ocean, to remain so for ages to come. Thus as one portion of land rises another sinks out of sight, and however limited, and in many respects imperceptible or extensive the operations may be, they are we reached our earth, with its first message of life, after becoming adolescent. As soon as that great event took place, be it earlier or later, its geological history began. Seas were at once formed, rivers ran into oceans, and the lowest stratum was now being formed. It is only by penetrating to the depth of this formation—a feat that will likely never be accomplished—that we could tell at what relative age of creation the event took place; but from then until now, we entertain very little doubt, many million years have passed away. During that time, most likely, transits of the earth through comets have been repeated more than once, at each succeeding event our planet getting clothed with a new atmosphere, every one more or less differing from another. As such ordeals have left no historic records behind them, except in the one case of the deluge, geological research cannot confirm whether they have or have not taken place. So far, however, as man has been enabled to dig down through all the more solid formations underlying the drift, there are no traces of a general deluge to be found. This only proves the absence of such an event during the growth of the strata up from that depth; but is no proof that it did not pass through a comet within that, to us, long period of its history; for transits through comets leave few abiding marks behind them, except in the very exceptional case of a great deluge. On the other hand, if the bowels of the earth at such a comparatively small depth as can be reached, show no traces of the earth in the long past having been drowned, in the sense of a sweeping force of waters over the dry land, the entire surface, as deep as the bottom of the drift, gives universal proof that the last great change it has undergone, was not in the scientific sense a geological change, but a general deluge that destroyed the most of mankind and large-sized animals. We have not to wade back perhaps millions of years to trace the event. Geologically speaking, it was one of yesterday, only a few thousand years ago, and the date assigned to it in Genesis cannot be very wide of the truth. It is, therefore, necessary to prove, before continuing the subject, that it was about that time the world was drowned by the sweep of the ocean over it, and that it was general, sparing no part of the dry land. If it can be shown to have been a reality, no natural force in existence could have caused it except the transit of our globe lengthways through a comet.

In the first place, some calamity about four or five thousand years ago must have destroyed the people of the world, for the earliest historic records lead us back to a time when few men were on the earth, and just in the condition we would expect to find them, sprinkled thinly, these having in the short time previous increased up to that standard from a small remnant spared from some universal calamity, whatever it may have been. Thus, peeping into the prehistoric period, just previous to these earliest written records and before the first empires rose, it is easy to judge that the earth from being almost deprived of human inhabitants was going through the process of being repeopled by the naturally rapid increase of population, in lands very thinly inhabited—an infallible testimony that some great calamity other than the ravages of war must have destroyed nearly the whole of mankind not long before; otherwise, the Asiatic races at least would then have been vastly more numerous. Let us add, everything handed down to us from remote antiquity, every relic of human art from the earliest periods, the rise of the first nations and empires, with an endless array of minor facts, taken altogether, form a mass of evidence direct and indirect of the most conclusive kind, when all are weighed together, that one of the great epochs in the history of our planet must have begun shortly previous. Whatever the calamity, it was universal, and not confined to any limited area of the globe, as is the case with geological changes.

To trace the comparatively late occurrence of the great event, by beginning with the first civilised powers, we find that there are not one on record more ancient than the Egyptian, after which the Jewish, the Chaldæan, the Mongol, and the Indian empires and nations followed, as near as we can judge, in the order they are put. We must take these as the earliest that existed; for if any peoples had been gathered into nationalities previously, some evidence of their pre-existence would have been handed down to us. We do not mean written records, but at the very least there would have been architectural remains, or the ruins of capitals such as Nineveh, buried out of sight by the hand of time; but they have not left a trace behind, nor a single vestige of human art—if we except antediluvian remains—to show the presence of the arts of either civilised or savage life previously. And if we search for the causes, we find that in the time before, near the end of the prehistoric period, the people were few and lived wide apart in the shepherd state, with innumerable flocks and herds, over uninhabited plains. In such a condition, population rapidly increased, rude villages and small towns eventually sprung up under patriarchal government, or tribes, the stronger in their feuds overcoming the weaker, till at last the nations mentioned—the first great powers in the world during its present epoch—came into existence gradually one after the other, and, with the exception of Egypt, almost simultaneously. The causes of these nations springing up, were that the people had increased immediately before from the shepherd state into a sufficiently numerical standard for the purpose, and with the exceptions of Egypt and Judea, each separate nation perhaps owing its first origin to a shepherd king, monarch of a wide territory, inhabited only by his flocks and herds, and a few servants, his near kindred. Abraham and Lot were memorable examples of this early condition of the world, before nations in the same places sprang up, and which at that time was the true condition as to population in most all lands. We read that as descendants of the same father they l together, and their respective flocks and herds so increased difficulties arose as to pasture. Right and left, however, here were wide regions unowned and unoccupied, so they had nly to divide the land between them—the one choosing Palesine as his grazing-ground, and the other all that land stretching owards Arabia. This is a true picture of the state that populaion had attained at the time in that part of Asia, and it no doubt vas somewhat the same in other parts of the world. Thus, by oing a few steps, or rather generations further back, we come pon the time when we can easily conceive of only a few human ouples, widely planted asunder over the face of the earth, small emnants of some universal destruction that shortly before had vertaken mankind. As there were no wars when people were o few, these couples increased rapidly up to the days of the two atriarchs in question, for the whole earth was a wide waste over vhich they could spread at will and have abundance. They coninued, as they must do, to increase, when about this time, or hortly after, the Egyptians took the lead, and became numerous nough to be a nation, and as mankind multiplied, the primeval mpires afterwards rose up in rapid succession, and a higher ivilisation and denser population naturally superseded the sheperd condition of their fathers.

The above facts—which are clearly established from all the nowledge we can glean from remote antiquity—taken together o to prove that the world, at least in one sense, had a beginning nly a few thousand years ago, springing up from that time to its resent condition from a few odd remnants of humanity. The bjection, however, may be put that all the tribes of Asia and urope may have existed in the shepherd, or worse, the savage tate for long ages before civilisation began. In reply we may riefly state that the shepherd followed by the patriarchal state an only exist in a country, continent, or world if you will, eginning to be peopled, and when population increases above that evel, as it is sure soon to do,—for in such a primitive state there an be no wars—the shepherd state as applied to all lands is for ver at an end. That we may have a clearer idea of the question, et us suppose some awful calamity, such as the deluge, to destroy ur island so far as to obliterate every vestige of civilisation, and weep our whole race away, except it might be one or two odd ouples who might miraculously escape. They would soon find hemselves the solitary ones left in a broad land now all their own, nd the rearing of sheep and cattle would be their earliest care, or it would be their easiest and shortest road to abundance. Their children would multiply, and their flocks and herds increase. n time the sons would grow up, each establishing himself in a eparate locality, and thus sons and son's sons would continue to lo the same, till at last, after a few generations passed away, the vhole land would be squatted upon. It is at this stage that patrirchal government begins. There is no longer anyunoccupied land o sit down upon, each family increases and multiplies over its own razing ground, seldom exceeding a day's journey across. Patrirchal government, therefore, under any circumstances can only be ephemeral, as all the families confined within their own bounds in a few generations increase into tribes. Border disputes very soon rise between them, and, for want of central government, tribe goes to war with tribe, thus putting an end to the shepherd state for ever. When wars begin with tribes, flocks and herds in the primitive sense vanish out of sight, and such a state of life can never be restored in the future. No matter to what extent wars might exterminate, there are no unappropriated or uninhabited plains for the cattle and sheep to graze at will over, in the sense that the herds and flocks of Abraham and Lot, Laban and Job, did in the olden time. It was only when population began that the shepherd state was possible, and in the then condition of the world it could only exist amongst people without regular government so long as there was undisturbed peace, but as a condition of society it could not last. They had no wars at first, because there were no contending interests to fight for; but in such a peaceful state of existence, as is the case at present over the plains of Australia, the people rapidly multiplied, till in a short time there were left no lands to squat upon, and thus the families soon increased into tribes. Both these first steps in the rise of population could not have lasted long, not more than a very few centuries, for up to this time it was the age of peace, and people by natural increase must have wonderfully multiplied, till the whole Asiatic continent—we suppose the other continental races never adopted the shepherd state—became covered with tribes that soon began to destroy each other.

The tribal state naturally superseding the patriarchal led to very different consequences in the east and west of our great continent; principally owing to the dispositions of the different races. The European at that time was as much superior to the eastern races as he is now, and from the moment he advanced to the tribal state, strange as it may seem, the virtues which exalt him above the other races, were likely to hold him down in the same barbaric condition for ages. Each tribe, for instance, looked upon its few miles of territory as its country and nation; they had no conception of nationality on a larger scale. Their narrow district was to them an empire,—their *amor patriæ* being much stronger than that of their descendants,—and as to their chiefs, or rather kings, they were all of the same blood and lineage, descended from a common father, for whom every full grown man was ready to lay down his life, rather than that his monarch or an acre of his little realm should be touched. It was no doubt the lot of the weaker tribes to be often conquered by the stronger; but it appears from the earliest periods on record that European conquerors always showed mercy to the conquered, insomuch that they never exterminated without any respect to age or sex. Hence, it was as great a difficulty then to entirely obliterate a petty tribe as it is at the present to blot out of the map, on a larger scale, any of the existing nationalities. It is owing to this state of things that Europeans at all times, by nature so much superior to the eastern races, were left at first so y centuries behind in civilised progress,—for in the purely il condition no people however gifted can advance,—and had ot been for the fortunate circumstance of the Roman conquests, most of Europe to this day might still be in its primitive bar- c condition, just for the creditable reason that in all ages they e had a natural repugnance to take the lives in cold blood of combative inhabitants, or, generally speaking, prisoners of war. tribal condition superseded the patriarchal amongst the eastern s in all respects the same as in the west, and like passions led tribes to war upon each other, but with them as it still is, if had the power, to this day, *vae victis!* The fighting men, the the mothers and youngest children were exterminated without cy, and the rest held in bondage. Their territory became a *ıla rasa,* added to and making a powerful tribe still more erful. Tribe after tribe were thus quickly blotted out, the nger overcoming the weaker, till lands that were partitioned countless divisions worked themselves, in a time compara- ly short, into the first monarchies after the flood. The rminating instinct of these otherwise mild eastern races made npossible that the tribal state could continue, and it is ques- able whether it even, as a general state of society, ever gained lid footing, for the causes were at work that destroyed the es as soon as they existed, and from what we can glean from records of remote antiquity, it is proved that the patriarchal monarchical states of society, in a great measure, ran into each r. These facts give us a chain of connected events which sputably prove that the beginning of our era at most could have been a few centuries earlier than these first historic its. The shepherd state, for instance, which all men admit existed, could only at that or indeed any other period be over ons that were beginning for the first time to be peopled by ıral increase, and as it was of necessity the age of peace, it and patriarchal state could not on account of the rapid increase of ılation be of long duration. As history therefore informs us the first monarchies, at least partially, rose out of the patri- ıal state, it is impossible to doubt that the account we find enesis of a new world of people that then had to begin again ncrease over the earth, as regards the time of the event ıted out, cannot be very wide of the truth.

he idea that our early ancestors lived for long ages in the ıge and then in the shepherd state has long prevailed, and has ı drawn from the examples of the Papuan, the Negro, and erican Indian races. It is in no respect applicable to the ıtic peoples—including Europe *—for although the different

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Properly speaking, Europe and Asia is only one continent, and had it not for the imperfect geographical knowledge of the ancients, the term "Asia" d have belonged to the whole, and Europe, on account of race, would been put down as one of its divisions, just the same as the Indian, the gol, and the Tartar divisions.

divisions are apparently not of the same lineage, they are all, even the lowest of them, of a higher type of humanity. There are passions natural to every kindred of the great continent, such as greed of wealth, love of power, and proneness to hoard up riches, feelings which never could have belonged to peoples springing by millions of years of evolution from the pure savage state, but rather from the beginning of the existing era; however low their barbaric condition may have been, they were never at any time lower than in the shepherd state. It is impossible that such peoples, however different their characteristics may be, could stand still and remain stagnant with such feelings implanted within them, if only favoured with the protection of enlightened government. The task is hopeless by civilised example to raise the aboriginal inhabitants of the other continents above their natural level; but all Asiatic races rise and advance, if they are justly ruled, and their universal innate love of property unquestionably led them to adopt the shepherd life, with some rude agriculture, from the first. Many of the interior small nationalities still continue in a condition no higher; but however barbarous or bloodthirsty they may be, from their nature and instincts, this, during the existing epoch, is the lowest condition they could ever have been in.

Let us go back and take for example the ancient Briton, a true type of the primitive barbarism of the European division of the continent. When the Romans invaded his country, they found him in the truest sense a rude unlettered barbarian; but even with all the disadvantages attending a total absence of the first rudiments of learning, they had made considerable advances on the road to civilisation—in the light that civilisation was then considered. They lived by agriculture as well as the chase, they possessed a few rude cities and towns of considerable population, besides having advanced to a knowledge of metallurgy, and also in possession of their domestic animals. They had their warlike instruments manufactured to wonderful perfection, and with their chariots of war sometimes made lanes through the Roman hosts; and could a nation of independent tribes have been united, they most assuredly would have driven their haughty invaders into the sea. Such was the condition of Britain at the time in question, and the Germans, Gauls, and other European races were undoubtedly on much the same level, and there is no question the comparison is applicable to every kindred and people at that time, in a greater or less degree, over the Asiatic continent. A knowledge of letters throughout its wide extent was only wanted for nations to spring up wherever population had sufficiently increased. This advantage, of painted signs and letters, the southern and eastern portions of the continent seem to have possessed almost from the beginning. As before observed, the people naturally resolved themselves about the end of the patriarchal state into monarchies, and as no large extent of country can be governed without the means of transmitting ideas, letters in one shape or another were invented.

In every age great inventions have been made just at the exact times they were wanted, and when they could no longer be dispensed with. The first monarchs had the rule of broad territories from a variety of circumstances thrust upon them, the government of which was impossible without written edicts. The invention, therefore, of painted signs, hieroglyphics, or some form of letters, was sure at once to be made. Thus, by these discoveries, they became the leaders in civilisation by several centuries in advance of Europeans, although the latter through all time, had they but possessed this advantage, would have been their superiors.

To compare all the gifted races of Asia with the other leading aboriginal races of the world, is like comparing the stagnant pool to the running stream. The latter races stand still and will not progress, for they are so philosophic as to prefer ease and indolence to labour and toil, content with the present and unambitious of the future: they would rather famish on little than work for abundance. On the contrary, whatever condition they may be in, whether in the lowest state of barbarism, which yet extensively prevails, or in the highest civilised condition, they—the people of Asia—have always had one and all a principle implanted naturally within them that, subject to the spur of necessity to drive them on, they cannot stand still, but from selfish motives must advance when they find it to their advantage, either by invention to economise labour, to amass wealth, or by ambitious projects, if possible, to obtain power and rise above their fellows. Amongst such peoples, in all past time equally gifted, and with so many shades in the mental capacities of the different races, it is a moral impossibility that throughout the whole expanse they would remain—so contrary to their nature—stagnant for ages. Everything therefore considered, the rise of the arts and sciences up to a certain level amongst the ancient Egyptians, Hebrews, and Chaldæans, would in the nature of things be reached by them, step by step, from about the time recorded in Genesis. Not that we take the chronology to be strictly accurate, for the account was evidently written from tradition; but a world of facts go to prove that it cannot be very wide of the mark. Thus, the earliest records and works of art, and the first nations that existed in the present epoch of the world having given rise to these arts, as a mass of evidence at least points out the era distinctly when civilisation properly so called began. Such gifted races of men, therefore, required only a few centuries from the first to reach this elevation, instead of remaining, as is supposed, a time almost interminable in a purely savage—or what is more in accord with the primitive Asiatic—a rude and barbarous condition.

All things considered, we may reasonably conclude, from the voluminous evidence that might be advanced upon the subject, that the existing epoch of the world commenced only a few thousand years ago, at which time a very few members of the human family were left, and from whom—some men singly perhaps becoming the fathers of nations—the present races of mankind have sprung. But, as all geologists know, this was not the first beginning of the world, nor could it have been the first origin of our species, for recent discoveries prove the creation of man to have been long anterior. Some universal calamity must therefore have taken place at this time, to reduce us as a race of beings almost to nothing. It could not have been a geological change, for besides such events being in all cases partial, the deltas of rivers and other fresh-water deposits prove that the present continental features of the globe have lasted for perhaps ten times the period. What the great calamity was, we will let the traditions of the different races of the world testify; not traditions related at the present time when the Bible is more or less familiar in all lands, but in the time previous, when knowledge from the sacred book was little known.

The Hebraic account, it need hardly be said, is, that the whole world was destroyed by a deluge reaching above the tops of the highest mountains, and the Chaldæan account is so nearly the same *ipsissima verba*, as proved by their tablets, that for our purpose it may be cast aside as knowledge borrowed from Hebrew manuscripts when they held the Israelites captive. Again, the Persians, Arabs, Greeks, and Romans have all their written traditions of the event, each one, as might be expected, differing from the other in some important particulars—the clearest proof that their knowledge was not derived from the same source. They all agree as to the water overlapping the mountains, but they differ very widely as to its universality. These are the written traditions, but besides, large portions of mankind have the same traditions, not preserved to them by ancient records, but handed down orally from father to son through more than a hundred generations. Tartars of the north, the natives of both Americas, and the races of India and China, have all their traditions of the deluge—their accounts widely varying, as they naturally became much confused by being orally handed down for so long a time; but all agreeing in one essential that at some far back time a flood, either partial or universal, in one form or other overwhelmed the whole or part of the world. If ever a truth could be proved by tradition, the deluge as a fact is established by universal testimony of the kind; coming as it does from every quarter of the globe, and from nations and peoples hitherto unknown to each other, it is impossible in all cases the information could have been borrowed one from the other, although this must have been so in the one instance of the Assyrian tablets. These were written shortly after the Jewish people were brought under them, or rather the Babylonians, in a state of bondage, and hence the origin whence they were informed of the flood; but this exception by no means detracts from the value of the other traditions of the event.

So far, we have advanced some very conclusive reasons which could, if space permitted, be greatly enlarged, that the present epoch must have commenced at a period not long prior to the

Mosaic account; and that it was brought on by a general deluge which destroyed nearly the whole of mankind is confirmed, as far as such proof can go, by a mass of traditionary evidence, oral and written, greater than is applicable to any other prehistoric event. The great fact will admit of much clearer proof, both by direct and indirect evidence, as the subject proceeds. Partly assuming the deluge to have been a reality that actually destroyed the world, it now rests with us to search for the cause; for if it happened, some great material force must have produced it. If we are to interpret the Hebrew account literally, it was brought on by forty days' rain, but as all the watery liquid held in suspense at any one time in the atmosphere could not have supplied a thousandth part of the water required to fill up the hollows and cover the hills out of sight—something like three miles deep all over the surface of the globe—the literal meaning of the passage may without the least hesitation be dismissed. The flood must therefore be otherwise accounted for, and there is no material force in existence which could have produced such a result, except a transit of the earth at that time through a comet. The comet, as is the case in a majority of transits, did not strike the earth broadsideways, for if it had, a general deluge would not have followed. Thus, to show the effects of transits under different circumstances, if the passage of the earth was sideways through the end of the tail, we suppose on account of the thinness of the elemental matter very little damage would be done; but if it passed through nearer the nucleus, the much closer condensed atmosphere in that part would act with devastating effect in raising up the oceans from their lowest depths; yet from the inconceivable velocity of the comet, when near its perihelion, the transit would be so quickly over, that however high the waters of the ocean might be raised they would immediately subside to their former level, without producing a deluge that would do more than surge over large tracts bordering upon the shores on that side of the planet exposed to the full force of the shock. The great event must therefore have been caused by the comet striking the earth end on, or nearly so. This would impose upon it the terrible raking force of a prolonged transit nearly through its whole length of fifty, or what would be nearer the mark, a hundred million miles, the length of the transit greatly depending on the angle of approach. The earth being thus raked in its lengthened passage through, with the tremendous force of the immense body of atmosphere composing it, rushing with that velocity common to all comets when near the sun, the force was at least sufficiently strong to drive the oceans, perhaps from their lowest depths, before it over the land. The raised-up waters were thus driven in front of the impelling force, not as a wave, but in ocean bulk as swollen mountains, during the hours of transit through the length of the comet, and when as a wrecked world it at last escaped clear, the real work was done; but the disastrous consequences in regard to the overflow of the waters to man and beast had not as yet time to be universal. The ocean waters continued by their own momentum to rush forward long after the impelling force of the comet was removed, in swollen bulk, perhaps higher than the clouds. Very soon the great heaps of water began to find their level, rushing right and left, part retreating back to their ancient bed, and part over that portion of the land not yet submerged, finally leaving not a foot of dry land uninvaded by the briny element. The high mountains could only have been a few hours covered out of sight. Indeed the presence of the waters on any part of the land was only transient. They soon rolled back again, the mountain tops first reappearing, while the deeper waters over the plains were likely in not many days back again within their native levels. And all was over.

The land soon became dry, but it was a boundless waste. We suppose that aforetime it was one unbroken scene of universal fertility, in great part covered with the solitudes of deep forests, within which innumerable species of animals together with man existed amidst natural abundance. The scene is changed. There is scarcely anything of life to be seen. There are no flowers, no grass, no forests—all is reduced to dripping plains of mud or hills of clean washed sand and gravel, with few living things to cheer the solitude. The largest classes of animals are root and branch destroyed, and for ever become extinct. Previously there were enormous mastodons, boars as large as elephants, hyænas and bears as large as horses and cattle, not forgetting the huge slimy reptiles of the mud. These devouring monsters, the actual "giants" of those days, mentioned in Genesis, were swept out of existence by the flood; never again to be the exterminating scourge of the future races that were to inhabit our globe. As a class, they were too large to withstand the shocks of the raging elements, and thus were all destroyed out of sight.

Among the larger animals, a remnant of which escaped to propagate their kind, may be included the horse, the bull, and the elephant.* These are all by nature good swimmers, and as we suppose they were very diminutive four thousand years ago, it is natural to suppose that some odd ones of their number were saved by gaining foothold on the mountains. Such prominences could only have been an exceedingly short time under water, and if these beacons of safety had not existed to providentially preserve one out of the million of the different species, all four-footed beasts, except the very smallest, would have been swept away for ever, and not a waif left behind. As it was, very few species of beasts were saved from total extinction that were not climbers and swimmers; and it may be here observed that some of the largest classes which became extinct were by nature climbers, but being too unwieldy they all perished. Some of the smaller species of the same races survived, such as the bear, the hyæna, and the boar, while many orders of the feline races, and perhaps the whole of the monkey tribes, being unendowed with natatory instincts, would have perished, but their climbing habits saved some of them by clinging to the branches of the floating forests as their arks of safety. Indeed, if we examine all the larger classes of animals, odd ones of which were spared to repeople the world, their preservation from extinction can be accounted for by their habits. The horse, the elephant, the bull, and other species of like size must under any circumstances have all become extinct;* but they are included in that general class of animals which, as time rolls on, imperceptibly gain in size, and reasoning thus we may conclude they were then much more diminutive. This being granted, together with their natatory habits, some of them being spared can be accounted for. Again, the preservation of the hippopotami, and other amphibious monsters, is due to the same habits in a higher degree, and with respect to those other monsters that propagate by ova their extinction was impossible. As to birds of the air, great numbers of all their species found refuge on the floating uprooted forests, and if we descend lower in the scale, the total extinction of any one species, whether animal or vegetable, was impossible. The reptile and the classes of insect life, were no doubt nearly all destroyed, and vegetation swept away; but they left their ova, spawn, seeds and larvæ behind them, out of which their races were very quickly reproduced.

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* We find the elephant conspicuous among the remains of the destroyed animals of the flood, and as large as the existing race; but being fur-clad they were of a different species. The progenitors of the elephants which now exist must then have been small, or not one of them could have escaped the ravages of the flood—their offspring from one generation to another having since gradually increased in size, for there is no other fact in natural history clearer than that certain classes of animals from age to age get bigger, but only so long as their increase in size adds to their utility.

As to man himself he was the same sized being, very little more or less, as he still is and what he always was, and will be; but the flint instruments he has left behind prove that if he was not then in a savage state he could not have been greatly elevated above it. Modern experience tells us that races of men in such a low condition are so expert in the water as to outrival most land animals, and that their climbing accomplishments are only excelled by the monkey tribes. We suppose it is to these two attainments, especially the latter, we owe the preservation of a single human being. To explain this more fully, and show that the accomplishments of climbing were at that time a universal necessity, we are to look on the antediluvian condition of the new order of things, foreign to their previous habits. But it is remarkable how soon the instinct of self-preservation will lead men and other creatures to accommodate themselves to existing circumstances, however different, and even to entirely change their former modes of life and still continue to exist, live, and thrive. The difficulties, however, of supporting life just as the flood abated, by no means pressed with equal severity on all races of animals. In the muddy slime left behind over the clay deposits insect life at once began to crawl in abundance as food for a part of the feathered tribes, while other birds subsisted on the berries of the ruined forests partially strewed about. As to the browsing races, they were entirely deprived of their natural food, grass and herbage; but there were every species of forest trees lying low, many of them evergreens, the foliage of which enabled them temporarily to live. The supply would last for such a short time as it would take the grass to spring up, as no doubt many of the trees retained their green for some time, through their roots being imbedded in the mud. The condition of the beasts of prey must have been at the outset much more precarious, and a large proportion of them most likely perished from want, as their natural prey, as well as themselves, were nearly all destroyed by the flood. They, however, as well as man, had one ready supply in the vast quantity of dead fish that the retreating seas must have left behind. This supply gave them abundance for about a week, and as it is well known that carnivorous animals can live for several weeks without food, before they all perished their natural instincts no doubt led them into ways and means of support.

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* It is possible that we are indebted for the preservation of some of our larger species of quadrupeds to the delivery of the young from dying mothers. The adults may have all perished; but many mothers ready to be delivered of their young, with their bodies almost mangled to pieces, grounding early on the mountain tops, in the agonies of death were possibly delivered of their offspring. Thus through these accidental escapes their species may have been spared; for it is well known, that the young of the larger races of animals can generally shift for themselves from the first.

As for man, or rather the few that were spared,—in some cases perhaps only a couple, out of whom a nation was to be born,—like the beasts of prey, he had enough and to spare from the quantities of fish left behind to begin with. From his previous sylvan habits, like modern people in the same condition, he found little difficulty in lighting fire to cook it with, and a temporary covering or wigwam he soon set up from the materials that were ready at hand. Before the flood he had to burrow down under the earth, as a refuge from the great monsters that held him in subjection, but now, when they were all destroyed, he could construct his rude dwelling in the open with impunity, and although as yet unarmed, his reasoning faculties soon told him that he was once more what he and his fathers had not been for ages, lord and master of creation. When provided with shelter he soon perceived that his temporary supply of food would quickly fail, so he set about laying snares for birds; for the feathered tribe must have been left numerous, as nature had provided them with better means of escape than any other class of animals. By this means, and the use of the spear and arrow, which his previous habits of life taught him to be expert in, he most likely obtained food for his preservation and support. In the meantime, the grass and other herbage, in places where the lighter mud deposits gave fertility, began to spring up, and the germs of the young trees of the future forests expanded from their buds. Nature thus in a short time unfolded herself into abundance for the support of the living. The cattle and other browsing animals rapidly increased, and the beasts of prey proportionately multiplied, as an indispensable natural prevision to check their increase from running to excess. In its exposure to such dangers, one of the most useful—the sheep—would soon have become extinct, if allowed to roam at will, but being early put under the care of its only protector man, it and the faithful dog were most likely his first domestics.

Amidst this dawning revival of nature, our antediluvian, his wife, and may be one or two male waifs who in like manner survived, began to encounter trials unknown to them in the preceding era. If their former climate was what we suppose it to have been, there were no clouds, rains, or tempests, and the whole evaporation of their days came down during the nights in dew. This gave the whole world the exact degree of moisture at all times wanted, and the highest possible fertility in all situations. Now, all was changed. A gross atmosphere received the evaporation as before, but it for the most part hung up in suspense, the new medium being too imperfect, by the coolness of the night, to restore it back to the earth, and like foul humours of the body held back, it came out, or rather down, at irregular times, in drops instead of in its natural evaporated state invisible atoms, sometimes with bursts of thunder, the grumblings of nature deranged, accompanied by storms and tempests more or less severe. The bow was now for the first time set up in the clouds of descending rain, which renders the passage in Genesis concerning the rainbow as figuratively imparting the knowledge to us that in the antediluvian time there was no rain. If the rain, now descending for the first time, had come with any degree of regularity, it would have been some consolation for being driven out of Eden; but our shepherd king soon discovered that in his new world and inhospitable atmosphere, the surcharged watery particles in the air sometimes fell in torrents and flooded the land, while at other times, through the long absence of rains, it was burnt up for want of moisture. These were the beginnings of his trials; but they brought with them the first dawn of civilised progress. In his antediluvian career no advances would ever have been made, for nature in a purer clime produced abundance for all his wants, there having been no impelling necessity to improve; but his condition is now reversed in having to face the difficulties of an uncertain clime. The spots he cultivated for the production of bread * he soon found to his cost were frequent failures through want of rain, and at other seasons swamped with floods; and to sum up all, his new and fickle atmosphere imposed additional

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* Whatever may have been the condition of our Asiatic projenitors before the flood, we believe they, by some means or other, partly lived by agriculture, however rude it may have been; for all their posterity, in whatever part of the continent they may be, or however low a condition they are in,—and ma

labour upon him, to make his habitation a fit abode in which to live, in clothing himself, and in the care of his flocks and herds. He was in a new world—the Eden he was born in, with its indolence and plenty, had passed away, and his life had to begin *de novo*, subject to incessant sufferings, the future lot of himself and his posterity.

But this Asiatic was the representative of a race highly gifted by nature, it may be with the exception of himself all destroyed by the flood, so he gradually surmounted the difficulties of his new condition by the energetic force of his will as these continued to occur. Sons and daughters were born to him, and his flocks and herds increased enormously over an unpeopled land. His sons having looked out for themselves wives, the daughters of a shepherd king, who as another waif spared from the flood had in a part far distant risen in like manner. It was natural for him to say to these his new married sons, "My flocks and herds have become so overgrown I cannot manage them, I will divide them with you; a great uninhabited land is before you, carry each of you your possessions to localities sufficiently apart which you may mutually choose, and with a father's blessing, go and prosper." Thus in due time the old patriarch had the happiness of seeing his sons' sons rising as solitary masters over the plains, for in such a primitive state of society population increased apace, and new centres or rather families multiplied over the unoccupied land, till at last, at the most two or three centuries, from a single parent the whole region that was ripening up to be a nation, became appropriated by a sparse population—somewhat like the wilds of Australia at the present—their wealth principally consisting of their sheep and cattle. This is a true description of the shepherd state as it takes its rise, a condition of society that can never exist in any land except at its earliest beginning of population, and in the primitive sense we have described. So long as it lasts, it is an unbroken reign of peace.

Population having thus far increased that there remained few new tracts to squat upon, patriarchal government immediately succeeded; for the waste lands being all taken up, each family, instead of spreading abroad as before, continued to increase in its own locality, and from being a patriarchate soon developed into a tribe, ruled by a chief, perhaps the true lineal descendant of their first patriarch born before the flood. Population, as was natural through so long a period of peace, having increased up to this level, border disputes led to quarrels, and as there were no laws existing betwixt the parties but strength, what was inevitable, chief went to war with chief, the stronger overcoming the weaker,

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the tribes are still as degraded as their ancestors in the preceding era,—must and will as part of their food have bread to eat. They always without exception have had it, and as they were of the same race, flesh and blood, bread, as the staff of life, must have been equally as indispensable to the wants of our antediluvian forefathers, as to ourselves.

and as was the custom of the time, the conquered were either exterminated or enslaved, but slavery in a milder form than in the sense we look upon it. This system of tribal government in Europe, on account of the different dispositions of its people, was liable to be permanent for any period of time; but in the parts of the east we are describing, as a system of government, we know from ancient history, it was only ephemeral, yet it had to exist so long as the people or rather their rulers were without a knowledge of letters, or at least painted signs or hieroglyphics, by which thought could be transmitted, or national government to be permanent would be impossible, as no written edicts could be sent out.*

It happened that a great river bisected the country, up and down which traffic went to and fro that supplied many wants of the tribes, and one great chief having his territory on its bank became more powerful than the others through the merchants finding a safe depôt on his dominions for their goods. Under him a numerous population thus sprung up, who lived in huts or houses that formed the nucleus of the first city of the plains, and it got the name of Babel from the fact that the merchants from many countries up and down the river spoke different languages from each other. Either by the traffic that was going on, or the inventive genius of some one of his subjects, the enlightened chief, whoever he was, got hold of the knowledge of letters or painted signs, and having made this important step in advance, he was put in possession of the one indispensable weapon of national government. He, or his son or son's son in succession, were thus enabled by the simple knowledge of the alphabet to spread their power wider and wider over the adjoining districts or tribes, who in the majority of cases were glad to put themselves under the new yoke to escape the exterminating petty wars they were harassed with. The easy conquests spread wider till the whole land, peopled by the descendants of the first shepherd king, was subdued under one power—the nucleus of the first empire—that soon afterwards claimed universal dominion. Egypt became a nation long before, and from its position there were causes at work which made it impossible that any spot in the world could anticipate her rising to nationality. Thus, if we look back to the time that men had only increased to families located sufficiently apart, there were then no wars, for new and unoccupied tracts had still to be taken up. The patriarchal system of government from the nature of things must be ephemeral, and the tribal condition, by the rapid increase of population in a state of peace, soon follows, and with it come wars, rapine, bloodshed, and extermination without any respect to age or sex. Tribe was constantly at war with tribe, and in their then barbaric condition mercy was seldom shown. It is to this cause that Egypt owes its rise as the first nation which existed in the present era; indeed, long prior to the other primeval nations and empires that followed. In the first place, we may observe that it is the only spot in the world we know of, that could possibly have become a nation so near the time of the flood; and secondly, there was at the time no political opposing influence that could have prevented it from rising to nationality when it did. Look at its position, a large rich delta of inexhaustible fertility, cut off on every side but the sea by deserts, while beyond these dividing belts of sterility were rich tracts of country, especially in the Syrian direction, spread over at this early period with innumerable clannish governments mutually exterminating each other, as was the custom of the time. To the vanquished of whatever tribe the Delta of the Nile was an asylum—such a place of refuge as few other tribes in the world, when conquered, could flee to for safety—to which as many as could ran to escape death or slavery. These escapes were not from one but from all tribes round the borders outside the deserts—at that time impassable barriers enclosing their land of safety—across which the conquered fugitives fled, while it was impossible their enemies could follow. Thus Egypt from its singular position—a land of promise, the key of two continents, and enclosed with deserts as natural barriers—was at first a land of refuge to run to from the vengeance of the slayer, and thither the vanquished of the Syrian, the Arabian, and Nubian tribes escaped in great numbers for shelter, while the postdiluvian epoch was but in its infancy. This particular nationality thus prematurely took its rise from these causes, long before the natural increase of population founded any of the other primeval great powers.

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* Without a knowledge of letters no nations could be formed, or if formed, would as quickly fall to pieces; for there would be no written laws, and the monarchs could transmit no commands that would be received as genuine. It is curious in tracing back the history of the world that all the primeval nations began with a knowledge of letters, and that no peoples after they had once acquired this knowledge remained any length of time, especially in the east without rising to nationality.

This first nation thus fortuitously springing up at a time so near the flood, when the rest of the world was as yet only peopled with widely scattered shepherds, and incipient tribes or families beginning to multiply,—entirely owing to its isolated geographical position,—went on increasing from the same causes; but instead of continuing to be an asylum for the distressed, they in turn became the greatest slave-owning nation we read of, and from the blood and stripes of their slaves they principally owe their historic greatness. They procured their slaves for trifles given to victorious chiefs, or kidnapped them by making raids on the defenceless populations beyond the borders of the dividing deserts,—for petty tribes bordering on a nation are always at its mercy,—who were compelled to cultivate their lands, dig their canals, and build their pyramids. This policy of obtaining and kidnapping slaves—as regards their white slaves they were no doubt drawn for the most part from Palestine and Arabia—continued for several generations, we might say centuries, till at last their white slaves by natural increase became very numerous, and acting secretly in concert, under the guidance of able leaders, resolved to throw off their bonds. In concert, therefore, about half a million of them, including wives and children, stored up in their knapsacks a few day's provisions stolen from their masters, and all the jewels and other valuables light of transport they could secretly lay hold of, and at a given signal directed their march—no doubt in the night—and together with all their belongings, light of carriage, they soon passed over the narrow strip of desert to the land of promise that was nearest them,—Canaan. Up to then that land was inhabited by the Syrian race, still divided in the tribal state under chieftains, who were called kings. The whole land, from soon after the days of Abraham up to this, was peopled by a comparatively thick population, divided into weak, and as far as we know, inoffensive tribes, pursuing a rude system of peaceful industry, and in a helpless condition to resist the terrible onslaught of a nation of uncultivated slaves who had just burst their bonds. As self-liberated white slaves they were in the true mood to tear and destroy. Under their leader Joshua, they marched over the land, and totally exterminated the people without any mercy to age or sex, till they were soon all annihilated, except a remnant who escaped to strongholds on the Mediterranean coast, the Philistines of the future, and a certain proportion, harmless in regard to number, whom it was their policy to preserve as slaves. The wild invaders thus entered into their houses already built, their garners, their lands, and all their possessions, without toil or labour, and from being bondsmen as well as their fathers, became a nation as it were in a day. From many circumstances, we suppose, but it would be rash to speak positively, they set up the second nationality after the flood. This we discover, by reading betwixt the lines of their own account, was the true origin of the Jewish nation, an idea we lay no claim to, for we have the high authority of Josephus that the educated classes of his day imputed to the Jews the same origin, but in one respect they must have been wrong in ascribing to them an Egyptian lineage.* Out of evil in this one great historic event good has sprung up, for we owe to the same people a collection of sacred literature that, notwithstanding the interpolation of some mythical fictions in the prehistoric account, will be a consolation and a delight for all time, and from them in the fulness of time sprang the Great Teacher, who has done more by His precepts for the happiness of man than the wisest men who have existed before or since. The nation thus established by violence, extermination, and wholesale appropriation, without a rival nearer than their former land of bondage, set themselves up as a kind of republic, and wisely refrained for a considerable period to extend their borders, and without ambition to acquire solid strength by increase of population. The same policy was continued for a long period under a succession of wise judges, or dictators, till at last they changed into the monarchical state. Their second king, David, became for that time a mighty conqueror, who added greatly to his dominions, and his son followed in giving to them splendour, consolidation, and strength. Immediately after, the kingdom was rent in twain, the one division in turn conquering the other, and thus the chances that were very great at the time of rising to universal empire, because of the absence then of any rival powers, were lost, and their career onwards was a downward one in every step of their history, ending in the Romans "taking away their name and nation."

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* We suppose the ancient Egyptians to have been a miscegenated race, originally sprung from an intermixture of Syrian, Arabian, and Nubian blood, while the white men they held in slavery, who eventually formed the Jewish nation, were a mixture of only the Arab and Syrian stocks, so that, if we eliminate the Nubian mixture, after all there was a near kinship betwixt the two races.

As everything connected with these earliest nations of the world indirectly establishes the deluge as a fact, or, at least, that our era began about the time mentioned in the Hebrew account, we must dwell with the tersest brevity a little more upon the subject. It was the fate of the first nations that rose to spread in the direction of universal empire, whatever might have been their policy, for they advanced to power in the midst of a world covered with petty tribes on their frontiers, who, so that they might be rightly controlled, had to be brought under. No matter how far these nations conquered, tribes succeeded tribes without end, till at last their dominions, especially those of China and Chaldea, according to their geographical knowledge, extended to the ends of the earth. Egypt, the first nation, was cut off by deserts from the rest of the world—somewhat after the condition of Great Britain surrounded by the ocean—so she had to stand still instead of spreading into empire. The Jewish people were cut short in the beginning of their career of conquest through their divisions, and the chances they thereby lost of reaching imperial greatness, were about the same time, or shortly after, embraced by the Chaldeans. The latter spread their dominions so wide that their monarchs assumed the title of kings of the whole world. To them succeeded the Assyrian, the Persian, and the Macedonian empires; but they all should be looked upon as the same Chaldean empire, continued under new lines of monarchs, and in different capitals, it being the self-same territory under different dynasties.

While the great empires were continuing to alternate in the east, the knowledge of letters was slowly advancing westward among races of mankind by nature far superior. Cadmus was the first to teach this knowledge to his countrymen the Greeks, and from thence in due time it passed to Italy—it is a nice question whether the latter had not obtained the knowledge previously—and as the discovery crept along, it is curious to see how nations rose almost *pari passu* with its progress. In Europe it enabled Greece to form itself into small, compact, and powerful states; while Rome, like Chaldæa and China in the olden time, laid the foundation of that empire which was destined to com-ıe whole of the then known world, with its arms spread ch wider than any of the empires which preceded. The of Rome, however, like all others held by the sword, had to succumb, and the broken fragments having all by this ›tained a knowledge of writing from their conquerors, be- ıations, instead of relapsing into the tribal state, which ise must have been their fate, with its exterminating petty imply for the want of an alphabet. With the fall of the ı empire, the time was past for any single power ever again ; the world in subjection by the sword. In respect to the s that heretofore spread out their conquests, and claimed al dominion, their presence was all that was required to the helpless tribes, which were then all but universal. the last of them, Rome, rose in the face of organised ; but it was the effeminacy of the east opposed for the ıe—if we except the Persian wars with the Greeks—to the ıncy of the west; powers that melted the same as in the : day to nothing in its presence. But since the decadence last of the ancient empires, a power with the ambition of al sway would have to face, not petty tribes or inferior ›ut organised and powerful nations, wherever their arms ›e carried. A Tamerlane or Napoleon might, by feats of ship, spread their conquests, but their unstable empires, r inherent weakness, would soon fall to pieces.

r Rome fell, a knowledge of writing enabled, at least, the t part of Europe to become divided into nations instead of but among the many powers that gradually moulded them- ›ut of the debris of her broken dominions, we may specially one that, in a sense, does not belong to the continent, but land in the Atlantic, in a high northern latitude, and with y clime. It is known as Britannia, and so small that it s contemptible in a map of the world. During the time of erial subjection, the best blood of the Roman soldiers be- nixed by their alliance with wives of the native race, and hey, as conquerors, at last abandoned the island, the Saxon in turn overran the whole country—the finest race of men nany, or, perhaps, at that time in the world—in such num- s to appropriate all the land to themselves. Like their ı forerunners, they had to take to themselves wives of the race—notwithstanding that the residue were banished to ›untains—from whom sprang a new race of Englishmen, ıe best qualities of the Celt, the Roman, and the Teuton d together. The Scandinavians, in turn, became our con- s, and largely settled down in the country; while the n Conquest brought in the best blood of France, as the xture of improvement. Thus, through the lapse of many es, the cream of the populations of the foremost races in :ld, the Roman, the German, the Scandinavian, the Norman, e Celt, have all been freely mixed together, the result being of modern Britons of indomitable energy, without an e in the past, and who will long continue, in whatever land they may be placed, without a rival in the future.

About three and a half centuries ago, the island was divided into two monarchies, with practically no foreign possessions, and a total population of about five millions; but since then its people have spread into every clime, have got undisputed possession of nearly all the waste places of the earth—except South America—and have increased from five to a hundred million, with the ocean commerce of the globe practically in their hands, and one half of the world virtually subject to their sway. We are not, however, referring to the little island as to its career in the past, but the wonderful figure her offspring will show in the future. A hundred years from the present—we are stating facts that will occur with as absolute certainty as the return of the seasons—there will be, perhaps, six or seven hundred million of Englishmen, in the enjoyment of their laws, language, and liberty, in America, Australia, Africa, and the United Kingdom, which will thus raise them to be the virtual masters of the greater part of the world. Will they at this figure stand still? No; they are by nature a race to whom not a spot of the world is sacred from their peaceful invasions. Whenever their own wastes are all taken up, their migratory waves in millions will seek new outlets among the inferior races, amidst whom their energies will profitably compete; and as the inferior is sure gradually but imperceptibly to melt out of sight in presence of the superior, it is not too much to say that, in a few hundred years, they will form the bulk of the population in nearly all lands out of Europe, and thus their laws, language, and liberty will in the end become the heritage of the world. England is the last of the powers which is making rapid strides to universal empire; but it is an empire of peace, gradually raised by the energetic industry of her children, a basis of power vastly more permanent than the fickleness of the sword.

CHAPTER XX.

THE DELUGE—*Continued.*

VING out of sight the future destiny of our race, let us observe we have thus far dwelt in the briefest terms possible on the of the primeval nations, not for the purpose of tracing their n—a scientific topic very interesting in itself—but to prove a knowledge of letters was first gained about the time of rise in the different parts of the world they respectively pied. This being a truth that every well-informed mind will it, it at once establishes the fact that there were no pre-existations, as without a knowledge of writing national government would be impossible. The question, however remains, ough we have already advanced the most conclusive reasons he contrary—Did it take a series of ages to rise up by ncement to a knowledge of the art? for on this depends the at which our epoch began. If we had the Negro or the rican Indian to deal with, no doubt ages might have passed re the great discovery had been made, for even if their intelal faculties were equal to the task, it is in the nature of these ant races to improve no higher than is necessary for their existence; but we are here reasoning upon races of another p, the most highly gifted in the world, possessed of faculties h would naturally lead them up to that all-important step in isation, during the time that passed from the flood as recorded enesis. We may perhaps be here confronted with the darling ry of the day, evolution, and be told that these Asiatics were ually evolved from being the lowest specimens of humanity the level of making the invention, and that thus in the ent epoch ages may and likely have passed away previously. ormerly observed, we do not deny the truth of evolution, however in the Darwinian sense, but even if he is right, his osophy in the present case will not apply. We have, for nce, the history of three thousand years on which our conons indirectly rest, and we find men, in relation to the races hom they belonged, much the same as their descendants of present. The statuary of Greece and Rome are monuments by universal assent are taken as true pictures of the public acters they represent, and in cerebral development they are inly equal to the highest of their modern descendants of the nations. And if we want any more proof of the sublime talents of the times we are speaking of, we have Confucius and Buddha, Herodotus and Homer, and the inspired writers of the sacred books,—a succession of luminaries immediately after the dawn of literature, each one of whom would be an honour to any age or country. Thus if we are to judge from such illustrious examples, instead of men being evolved higher, they are, if that is possible, retrograding mentally into a lower condition; for not one of the nations that gave birth to these great names have for the last fifteen centuries produced a single genius that will permanently live in history. At all events, the mental capacity of these peoples was at least on as high a level three thousand years ago as they are at present, hence their forefathers must originally have had natural abilities little inferior a thousand years earlier, or near the time we suppose was the beginning of our era. During such a period so gifted a race, although in a rude condition, from necessity would push on in improvement up to the level we find them when the primeval nations first rose, and it was just such a period of time, with uninterrupted peace, that the descendants of a few couples would reach by natural increase the level of population at the time. When we take all these circumstances into account, together with a total absence of relics or any works of art, whether architectural or otherwise, and the well-known thinness of population in all lands that ancient records make mention of, as to the time immediately previous, a mass of very conclusive indirect evidence is given us that very strongly confirms the Mosaic account handed down to us, although we are not sure of the perfect accuracy of his chronology, for the great event may or may not have happened at a somewhat earlier period. When all things are considered, the period since the beginning of the present era cannot therefore be more than a few thousand years, and as the Hebrew tradition, corroborated by the traditions of many other nations, without any previous intercourse with each other, all agree as to the same fact, we have as clear proof as it is possible for traditionary evidence to give, that it began with a universal deluge that only spared an infinitesimal remnant of the respective races of men to repeople the world under a new order of things. We mean not, however, to rest the proof of the deluge alone on tradition and history, but will now muster an array of facts that will establish the great event as clearly as any geological truth.

No men of engineering capacity but must have a broad conception of the wonderful effects that would be produced on the land by the force of the ocean sweeping over it, and such we suppose was the deluge. Thus, a comet with its inconceivable velocity—an enormous body of atmosphere of millions of miles in extent, in part closely condensed—striking the earth, was just the force that would drive the oceans over the land, not with a sweeping strength to change the general features of islands and continents, or to root out mountains from their bases, but sufficient to wash all before it, including the deposits of thousands of years on hill and valley, in most places not too much depressed, to the bare rock. In many localities, little hills, mountains composed of loose materials, such as volcanoes, vanished before the shock; and the mountain ranges were shorn of their weaker peaks, of their rugged eminences and jagged outlines, and left bare and comparatively bald. The entire debris, stones, gravel, and vegetable deposits, the uprooted forests with all their animals, man included, were mixed and churned up in the gurgling element indiscriminately, and the great volumes of water retired back to the ocean and left the mountains bare and stripped of their bolder outlines. The deposits previously upon them, except in deep places, were carried hence, together with the other broken-off materials all stirred up in common, and then settled down wherever lowlands existed, rendering them all into comparatively level undulating champaigns. Such we suppose were the effects of the deluge on a large scale, and all the particulars of the description are borne out by every spot of dry land on the world, be it mountain, valley, or plain. Mountains, wherever they may be, have all in a large sense rounded outlines, without any peaks or prominences left that were not of sufficient strength to withstand the shock; the lowlands were rendered of undulated level, through the deep gulches and basin-like depressions, hitherto natural to the scenery, being filled up with the debris that the receding waters swept down from all high places. These undulating expanses are not partial, but the common features of every part of the earth's surface, and what we have said of mountain features are in like manner universal. There are no mountains on the face of the globe, no matter into what land we travel, but have imprinted upon them the sweeping marks of the flood. Their tops are still bare, just as on the day they were clean washed by the rushing waters; and descending lower down, they are coated with a thin covering of natural deposit, such as we would expect to be found from atmospheric decay and the vegetable deposits of four thousand years. It may truly be said that gravitation, and the constant washing down of the rains, would account for these high places being bare. Undoubtedly, from these causes, much smaller deposits are to be looked for than in the valleys below; but if there had been no deluge such as we maintain and have described, we would look for the smaller deposits, left as thin coverings on the mountain sides, to be of the same composition. Thus all deposits high up on mountains are composed indiscriminately of mud, stones, pebbles, and other matter, with a certain complement of vegetable decay, just the natural condition mountain deposits have since taken, undisturbed by a deluge; for we are to bear in mind that the flood left the mountain-rocks clean washed, no portions of the antediluvian deposit being left behind. On the other hand, when we descend to lowlands—and it is the same in all parts of the world—the formations one and all are totally opposed to the order of nature, when put in contrast with the changes now going on. They universally represent the true condition we would expect after the bulk of ocean had passed surging across the land, and as suddenly returning back within its native boundaries. If there had been no deluge, we would have no brown sands, gravels, and clays separate and distinct, but all would be equally compounded together and intermixed with the usual proportion of vegetable decay, much the same as our present mountain, sea-coast, and island deposits, and in which state, no doubt, all deposit material existed before the flood. All men are agreed that these lowland formations are from the effects of currents of water, as to the gravel and sand-beds at least they apply the name of drift, which they certainly are; but their ideas are somewhat foggy as to how or where the water came from, for as the drift is universal so must have been the waters that washed it. The water could not have been from the sea, as a permanency, or else marine remains would be mixed up in great abundance; nor could it have been from the action of fresh water, or the drift would be partial, in isolated threads tracing the ancient courses of streams; whereas the washed stuff is universal, covering all low-lying lands with the exception of rocky protuberances, sea-coasts, and islets. There are no deposits made within historic record of the same description as is common to all the plains of the world, but what have since taken place are universally of the natural order, which proves that the rest must have been subjected to a sudden and universal washing, and only the oceans could have supplied the waters in sufficient abundance.

The washed drift on champaigns is of various depth, from next to nothing to hundreds of feet deep, which proves that the antediluvian scenery underwent a wonderful change in being reduced from a natural ruggedness into a comparatively level state. Again, the colour of the drifts that thus fill up the gulches and hollows of the old world proves that the washing operation, which all geologists admit they were subjected to, was short and sudden, otherwise they would, like the sands on the sea-shore, have been bleached white had they been acted upon for any length of time; besides, marine remains or fresh-water shells, accordingly to whether the acting agents had been salt or fresh-water, would under any circumstances have been thickly incorporated with them. There being therefore no shells of either seas, rivers, or lakes found in these world-wide deposits, together with the colour of the materials, settles the question beyond all doubt that the great work was short, quick, and universal; and it being admitted by science that it was the work of water, from its universality it could only have been the waters of the oceans. They left the material, if mineral, for the most part washed clear of mud in their native rustiness of colour, being soon—without long continued wear and tear—left dry, unmixed with marine remains; and these effects being common all over the world, evidently stamped with the marks of a single date, form together a mass of evidence we can only touch upon, that no other force but an invasion of the ocean and its sudden retreat could account for. What could be stronger than that all the loose stuff covering the earth has been unmistakably subjected, except recent deposits, to immersion, that its colour proves it to have been a day or a few days at most under the water, and that the effects are universal and uniform, with an endless array of facts which might be added, all establishing the truth of the wonderful event, and that the changes produced were simultaneous! No possible invasion of water in existence could at the same time spread over the whole globe with an extremely short delay—which the colour of the washed materials proves—except by some external force impelling the oceans over the land, and their sudden subsidence in its absence within their ancient boundaries. The passage of the earth through a comet supplies that force, and meets the circumstances of the washed drift in all particulars.

In the retreating floods of the oceans rolling off from the land, all ancient deposits being mixed up with them in common by their force—deposits as old as the continents—it was in the nature of things that collections of pebbles, stones, and sand would be brought together by themselves where the ebbing currents were strongest, and that the mud, made up greatly of vegetable decay, should settle and sink down partly beneath the eddies and on tracts where the waters were temporarily still or least disturbed, and form the clays which as deposits still retain a richness of fertility, no matter at what depth. How naturally the gravels, clays, and sands all included subsided, not like river deposits in flats, but into the undulating condition of hill and hollow, just the shapes and forms that under the operations of the retiring floods we should expect to be imposed over the universal scenery. The stirred-up materials were unequally mixed in the waters, and they had to settle down into unevenness. These undulating features prove the present operations, which are and have been at work for thousands of years past, could never have imposed them upon the land; for, instead of raising undulations, all that have been going on since continued rather to level them, and it is beyond human ingenuity to account for such universal swellings—not rocky hills—on the plains, except by a general deluge. No general deluge is possible except from the ocean, nor is there any other force in the universe which could drive the oceans over the land except that of a comet, and it would be powerless for the purpose if composed of any other material than atmosphere.

There are no portions of the earth's crust that are or can be so familiar to geologists than the clays and gravels on its surface, and from their washed condition, together with the two classes of deposits, the muds and the minerals, being in great part quite distinct from each other, instead of in a natural state mixed in common, they all conclude that by some unexplained process the whole universally—at one time or other, ages widely apart—were subjected to the action of water. How or where the water came from so as to produce the same uniform effects in all places v men tread upon, we are not aware that they have answered in their researches through these drift deposits they disco that there were millions of stones, or rather boulders, every mixed up with the drift, not belonging to the underlying s They were in all cases traceable to mountain formation of ki rocks, more or less at a distance, which they justly consi the changes now going on could never have transported h The difficulty was solved by some one witnessing, in a l northern latitude, a boulder imbedded in a block of ice tha ing a thaw was drifted by the wind to the opposite side c lake, and of course deposited on the shore, and underneath, observed, lay a different species of rock to that side from w the boulder was drifted. Being thus accidentally wafted fr native rock, it was called an erratic, and the millions of found everywhere through the drift were afterwards consider some means or other, by the assistance of lakes—lakes mus have been very numerous—to be sown broadcast by floating l of ice, when broken up by thaws. Only a mind of sublime ception could have made the observation, and in honour discovery these wandering boulders were termed erratics these erratics are alike common in all latitudes—tropical or wise—to uphold the theory glacial epochs had to be inv that is, for immense periods of time all parts of the world winter seasons were ice-bound. Wherever these erratics are —and they are more or less universal: indeed the gravel from the smallest pebble upwards are often nearly alto composed of them, according to the near or more remote mity of other rock formations—they can easily be account by kindred rock formation seldom many miles distant, and, i of substantiating the truth of glacial epochs, is one other uni proof of the deluge. A force that was strong enough to s down the rugged outlines of the mountains, where their nences were weak, had equal strength in its ocean torre carry far and wide over the plains much of the broken frag and loose blocks; and a still clearer proof that it was the w the deluge, and not floating blocks of ice which scattered countless millions of erratics far and wide, they are in all situ found to increase as we approach nearer to the sources o supply.

Let us now search down to the bottom, and take a broa of the contents of these world-wide drift deposits, and se wonderfully everything connected with them establishes the of the deluge. They are all so deposited that in some spot the plains the rocks crop out, while they are only a few fee in one place, and not far away perhaps above a hundred fee in another, thus showing the natural operations of the sw force of the deluge in filling with the washed-up old antedi deposits the rugged gulches and depressed basin formati the old world, giving to the wide expanses their undulatin condition, instead of the rough broken scenery which in accordance with nature hitherto prevailed in lands both high and low. And no matter how thick these deposits may be, the whole continues from the bottom upwards to be an indiscriminate mixture, without the least pretension to stratification properly so called, which conclusively proves that one grand operation placed them in their total thickness, for had they been gradually formed they must have consisted of a succession of regularly formed strata. This, taken together with the fact that none of the materials have been bleached out of their natural colour, proves that the process of their formation, from the bottom up, was short and simultaneous, and such that no material force in the universe could have brought about except a general deluge, which in itself was an impossibility except from the atmospheric sweep of a comet. Indeed, as to facts in proof of the event, they are inexhaustible, for every foot of dry land on the world adds its quota of testimony. Let us now examine the contents of the drift for antediluvian remains, as additional evidence of a general deluge. Deep down in the drift trees or dead bodies were not likely, except in odd cases, to be deposited, for being the lighter material they were for the most part carried hence by the retreating waters, or left high and dry to vanish out of sight.* Nevertheless we find in the drift at various depths, as chance circumstances may have placed them, remains of the existing races of animals, including odd ones of the gigantic monsters that the flood rendered extinct, and not only these, but many of the flint implements that were then in use, all mixed up in common, just in the natural condition they would be deposited in the ruins of a world destroyed by the sweeping force of the ocean passing over and retreating from the land. The great monsters becoming totally extinct, and all other species, of which a remnant might escape, and that these still exist prove that no other work but a deluge caused their extinction; and were it not for that event, they would still be prowling about as a continued scourge to the human race. Again, the flint instruments so frequently met in gravel deposits, prove themselves to belong to a single date, not older in fashion than the lifetime of the dead men's bodies found sometimes in the same deposits. They are all of a common pattern, whereas if they had found their way into the drift through a succession of ages, as is generally supposed, they would differ in make and shape.

Let us again shift our ground and prove the reality of the deluge from what is known of the deposits in the lower valley of the Thames. If the deposits of other river beds were equally well explored, there is no doubt they would give their mute proofs in millions equally as conclusive. Most of us know, or at least have read of this classic valley, with its wide Essex, Surrey, and Kentish flats, and the natural embankment of the river which protects these flats from being constantly overflown by the recurring tides. The sweep of the deluge for the time being filled up level with the drift stuff the channel of the river, and spread out a stratum more or less thick of the same washed flinty materials over the adjoining flats, or rather what they were immediately before in the antediluvian time, wide lagoons spreading out on all sides, under what have been rendered low level expanses or dry land by the same operations. The lagoons got all filled up to at least the level of low water by the force of the retreating flood carrying down with it the sand and gravel mentioned, and the old river channel all in common, leaving an unbroken level the same as the flats still are. The gravel and sand, however, in the river bed lay there in a half-swimming loose soft condition, the same as all such materials are in before the water entirely drains out of them when suddenly flooded together. The successive tides very soon cleared the loose gravel and quicksand out of the river channel, carrying with them these uncombined materials, in part to the sea, but a large proportion by the well-known rushing force of the tidal waters was deposited on each bank, the flowing and ebbing stream ploughing it up in great quantity on either side. This is the true operation that gave us our natural embankments, a superhuman work erroneously ascribed to the Romans, and which, as far as we can learn, are common to the tidal portions of all great rivers in whatever parts of the world they may be—in themselves universal monuments left behind of the effects of the deluge. In fact, its sweeping force filled up all river channels, and the ebbing and flowing tides soon cleared them out by their rushing force, part going to the sea, and part with the ploughing force laid permanently on each side. Hence the natural embankments which we believe are common to all great tidal rivers in their passage to the oceans, and which protect from daily inundation their flats and deltas, some of the most fertile portions of the world.

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* The clay deposits are more likely to have within them a greater proportion of the remains of trees and animals than any of the other formations of the deluge.

These Thames flats, as just observed, on each side of the river embankments were previously lagoons, but now left covered over to a certain depth by the operations of the deluge with a mixture of washed sand and gravel, in about equal proportion, and of that brown rusty colour which distinguishes the drift brought down by that event in all situations. Under this layer of sand and gravel, as a general rule, there lies a stratum of peat more or less thick, according to the general features of the ground, and lower down again succeeds another mixed deposit, which descends as deep as the chalk. The gravelly stratum on the surface, we need scarcely say, is made up of the materials swept down by the deluge and thus left behind; the deposits underneath the peats are antediluvian, being at a level low enough to have been free from the surging force of the flood, while the peat itself is composed of the vegetable remains of rank fresh-water growth, which settled down at the bottom, and thus in time made up these thick boggy formations under the old lagoons. If these Thames deposits were better explored for a depth down to the peat, some of the secrets of the flood might be revealed to us that we are ignorant of; but sufficient is already known to inform us that all these flats are storehouses of antediluvian relics, and thickly planted with the dead remains of that era. In most places we sink down through the gravelly stratum, we hit upon the bones of the existing animal races of the country, in addition to elephants and other species that the flood rendered extinct. In one word, these flats are throughout a common grave of the races of antediluvian animals native to the soil, with some canoes, and no doubt other relics of human art belonging to the Adamic period.

We may be permitted to ask, What brought all these things together? The peat itself, from its position, is easily accounted for, as well as the deeper deposits; but the gravel overlaying the peat, how did it come there? No natural operations which are at work, or that have occurred for thousands of years past, could have brought a particle of it; but there it is, superimposed over the peat in various thicknesses, stuff newly washed, and as suddenly left dry, all unmistakably the work of a grand, short, and sudden operation. Again, how is it that this top stratum is the grave that covers millions of the dead, the progenitors of all the wild beasts natural to this part of our island, and those which have become extinct? Some odd wild animals were no doubt about, and died; but as these creatures were so uncivilised as not to think of burying their dead as nature called them off, they soon decayed out of sight, and none being artificially buried, how is it that the remains of such multitudes lie in the drifts of our river-flats? There is nothing going on or has gone on in the known past to explain the mystery; for if the river was still in a state of nature, and its banks roamed upon by myriads of wild beasts, from the natural changes that are now going on the dead body of a single one of them would not accidentally get buried, so as to be preserved once in a thousand years.

The deluge meets all the circumstances. Over the whole range of the Thames watershed, the races of animals that we find buried in such numbers in our midst were ranging or quietly browsing over hill and valley of the richest fertility and great natural abundance—bestowed, we suppose, upon the land by a purer atmosphere and cloudless sky—when they were suddenly overtaken by the destroying avenger, the flood. In its retreat from the land, in the part of the island drained by the river, it naturally rushed in greatest bulk and force along its course to the sea, bearing along with it a portion of the surged-up deposits of ages, the uprooted forests and the dead bodies of the drowned animals all confused together towards the ocean. The whole did not, however, descend into its capacious bosom. A vast quantity continued to settle down throughout its onward course, and no position in the whole land was more favourable for the dead to settle down than on the river lagoons from London to the sea. Thus, the river-flats and the sea being on the same level, the retreating floods were more still, so that a considerable portion of the dead bodies had a chance of settling down and getting buried by the drift that followed. Such are the relics left us of the last era, a store rich in abundance. If these and other localities, especially flat low-lying marshes, were scientifically explored to any great extent, our knowledge of the latest Adamic times would be wonderfully enlarged.

While dwelling on the effects that the deluge produced in our valley we cannot help referring to one other remarkable monument it left behind, not in England, but far away at the mouths of some of the Siberian rivers on the frozen ocean. At or near the outlets of these great rivers there are the remains of unknown thousands of fur-coated elephants buried in the mud or drift, packed so close that their tusks, washed bare by the action of the water on the banks, are so plentiful as to be an article of profitable commerce. How deeply their common burying grounds extend laterally into these frozen deltas no man can tell. The remains of the elephants, however, are there in thousands, and there are no operations at work or ever have been, except the deluge, that could have deposited their bodies in such numbers where they lie. They could not have been natives of the place, for it produces nothing on which such animals could live. Some force, therefore, must have carried them thither, and we repeat that no other force could have done it but that of the deluge. We can well conceive of a time when the entire steppes, from the Himalaya down the slopes to the north, were ranged over by countless thousands of these huge animals—the ocean deluge came upon them, pouring down over the Himalayan ranges with its sweeping force, from which not one of them could escape on account of their unwieldiness. They were borne along by the great retreating floods down the river-sheds, where the currents were naturally strongest, till at last a certain—perhaps a great proportion of the whole—floated to where the currents ceased to carry them farther, for like the Thames flats, the deltas are on the sea level, so that many of the dead elephants when brought thus far, settled down in the positions they are still found. There is perhaps no other collection of antediluvian remains in the world, which gives a clearer testimony of the reality of the flood than the presence in one place of such a number of elephants all of an extinct species.

CHAPTER XXI.

THE DELUGE—*continued.*

THE origin of man naturally connects itself with our subject, but the relative time at which he first appeared—a question out of our power even to surmise—or his antiquity will not concern us, except so far as it relates itself to the deluge. All the human remains that are discovered in the flood-drift, no matter whether these may be near the surface, where they are more likely to be on account of their greater lightness, or deeper down, give us not the least information on the question. The whole of these formations were produced by one grand operation, and the bodies of men and animals within them must be all of the same date, however deep down or near the surface they may be,—all swallowed in together. If in the antediluvian deposits * human remains were to be found, we would, according to the depth they might be, have some clue as to the antiquity of our race; but if there is no such evidence so far as the Adamic era is concerned, we must be content to remain altogether in the dark. Again, Has he existed before the Adamic period, continued throughout that long interval, and from then down to the present? If we are to look for his beginning earlier than the last epoch, it must of course have taken place anterior to the present continental system, and this would lead us a step farther back to the examination of the latest stratified rocks, either for his remains, or some marks of his handiwork. If therefore no tokens of the presence of man—human art or otherwise—are to be met with in any of the secondary rocks, we may reasonably infer that his first appearance was some time near the beginning of the last era. Until some discoveries are made in the recent rock formations to the contrary, we will hold fast to the conclusion, and reason out the subject on the basis that his creation took place within the limits of that time. The latest secondary rock formations must necessarily lie at present deep under the sea. In another geological epoch a portion of them at least will be again elevated into dry land, and it will, when that time arrives, be discovered whether there are any marks within its strata of human art. Without such an impossible item of knowledge, it cannot be positively determined whether our race preceded the present conformation of the world or otherwise. But if there will be found no such relics when these last submerged continents may be again heaved up, and, as we suppose, none are held within the most recent formations within our reach, on such evidence, the possible and impossible, we could reasonably conclude that man's creation must have been sometime within the existing geological epoch. If rational beings had lived in any former epoch, some of their marks would unquestionably be left behind them.

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* The antediluvian deposits, although concealed by the drift, are still in immense quantity underneath, in deep sheltered places that were free from the sweeping force of the flood, and can never be mistaken, for they are unwashed and of natural mixture, like the surface deposits since that time.

Proceeding therefore on the assumption that man was for the first time born into the world since the present continents arose, he of course cannot be of higher antiquity; the ages of the continents themselves, however, differ very widely. Asia, the cradle of civilisation and the source of all our knowledge of remote civilisation, by consulting our prejudices we would pronounce to be the oldest continent; but viewed geologically, it is actually the youngest. Africa, we suppose, is nearest to it, or it may be about the same date; while the least known continent, South America, we presume is vastly older. Our unerring guide as to their respective ages, is the breadth of the alluvial deposits of rivers, for deltaic formations, whether in the interior or on seaboards, must always be wide or narrow according to the time the dry land they are drawn from has existed. Yet, when we judge of the comparative ages of the continents by this unerring standard, there is abundant proof in the widely expanded deltas of the Indian and Chinese rivers, and the rivers of Europe, such as the Danube and the Po,—although as nothing compared to the pampas of South America,—that the Asiatic continent has been long above the ocean, how long no man can tell. It is only by knowing the rate at which the deltas themselves progressively increase that such knowledge could be arrived at, or that we could even form the most vague idea of the period of time which has passed. It may, as a continent, have been high and dry not more than a hundred thousand years, or, what is more likely, its age might be treble the time; but, in such speculations, we must bear in mind that the deluge very considerably added to these deltas, as it was principally through the riversheds that the flood exerted its greatest retiring force, in bearing along with it the turned-up deposits of the land. At all events, let the time be long or short, till we have evidence to the contrary in the stratified rocks, we may reasonably conclude that rational beings first appeared on the scene, earlier or later within that time,—the geological periods of the present continents.

How or under what circumstances human beings were first created is another fact that investigation will, most likely, never make known; but this we might venture upon,—evolution notwithstanding,—that humanity sprang not from one common stock, but that the various types originated at times different from each other in their respective continents. If they, for instance, had ll descended from one common origin, or rather from the same arents, the superior becoming according to Darwinian philosophy volved from the inferior in course of time, according to the hanges or rather no changes we have witnessed for the last three housand years, it must have taken millions of years to have evolved ll the varieties of the human family that now exist. Now, granting volution to be true, the world is certainly old enough to have proluced the changes; but on the other hand, if all took place within he present geological epoch, it has had no time to evolve so many aces in the ascending scale, and mankind must have first come nto existence during that time, if there are no remains of human rt at least in the strata lying immediately under the antediluvian eposits. Besides, in the grand divisions of the world, except sia, there is in reality only a single aboriginal race on each coninent, and, except that rationality is common to the whole, they n all other respects differ as widely from each other as if they had elonged to other planets. We may be in error,—and everything hat is partly conjectural is far more likely to be erroneous than therwise,—but we suppose that races peculiar to each continent ll sprang up separately from their own respective origins,—their dams and Eves if you will,—not simultaneously, but it may be at arious times within their present geological epochs.

As regards the Asiatic continent, it differs in this one respect, hat it contains within itself a variety of races, apparently of diffeent origin. The European, the Tartar, the Mongol, and the ndian are four distinct races that make up the bulk of its popuation, and they vary from each other so much in character and olour, that we would be inclined to think they have all sprung rom different origins, were it not that there is a wonderful affinity etwixt them, which might be construed into a kind of kinship. The intellectual faculties of all the races, if under favourable cirumstances, are nearly on the same level—they all in common ave much the same feelings of a love of gain and lust of power; heir passions of love, hatred, and revenge are much alike; and inally, when in the enjoyment of enlightened government, progressive, but with this universal weakness, that it is the animal ropensity of supplying their wants which urges them on in progress. With them "necessity is the mother of invention," and owever low the motive, it is the one important step that places hem above the other races of our planet, who will invent no urther than what will preserve existence. There is another link hat binds all our continental races in common: in however low a ivilised state any portion of them may be, if their soil can only be made to produce, they are all in some rude form or another agriculturists, and it is an industry that to some extent they must follow. By nature, they are so constituted that they must and will have bread as their staff of life. Even to a limited extent the wild Bedouins of the desert and the Tartar hordes of the frozen north raise bread, and whatever they may eat besides, there is not a single people over the great area of the continent but longs for the produce of the soil as their favourite food. No matter what condition they may have been in, either since or before the flood, the pursuit of agriculture in all time past was, we suppose, one of their industries.

Taking all the foregoing reasons collectively into account we may concede this much, that there being so many characteristics common to the Asiatic races, it may be barely possible that they have all sprung from the same parentage, and notwithstanding the dark Indian and yellow Mongol, evolution might have—although we hardly think so, for there is only the duration of the present geological epoch to account for the changes—produced the marked developments which now distinguish them. Taking this, whether true or false, for granted, we can conceive of a time when Adam and Eve appeared, but how long since is the question. Conclusions of late have been drawn, that it must have been something like two or three hundred thousand years ago, this high antiquity of man being accounted for from the depth some of his remains are found below the surface. We need scarcely repeat that the depth at which human remains are found prove nothing, so long as they are not met with in the antediluvian deposits, nearly all of which underlie the drift. If it is in the latter that all the skeletons are found, it just proves that they were the victims of that universal calamity which drowned nearly every man then in the world, and at whatever depths they may be within the same formations, whether man or beast, they all lived and died together. Indeed, so far as such discoveries go—always prevising that they are within the drifts—they are in no respect opposed to the chronology of Genesis, that the first man was created only two thousand years before the flood; but we must look upon the writings of the inspired book as not for the purpose of teaching science, and the dates, especially of the prehistoric period, were only given figuratively. It is sufficient that they have noted down the important fact, leaving us to judge of the relative period according to the light that is within us.

As we cannot literally accept the Mosaic account of the time that man was created, and as we have very weighty proof that it must have been sometime within the present geological epoch, in the absence of ascertained facts let us take an arbitrary period —it must be a long one to meet the conditions of society that in course of time followed—and observe that Adam and Eve were created, say fifty or a hundred thousand years before the flood. Either number will alike meet our purpose in tracing what we suppose was the condition of our antediluvian forefathers; besides, we have sufficient evidence from the river deposits that the continent is at least of that age. When created, one of the first commands given them was to be fruitful and multiply and replenish the earth, and there is no doubt but that they had both sons and daughters. Adam was also from the first appointed lord of the creation, which of course in great part long pre-existed, and to consummate their happy condition, the couple were placed in a lovely garden called

Eden, which produced every kind of fruit and an abundance of ll things for their support. The whole earth comprised the arden, for it was then under another atmosphere, which the omet of the deluge afterwards carried away.

We suppose it moistened only with dew, in which case there were no rains or tempests, every spot of land produced the utmost nfailing abundance, the weather according to the time of year ever changed, and the seasons were certain. Whether it was a ingle couple at first is little to the purpose, we know that it must ave been a small beginning, and in the midst of abundance uch as we imagine, their first advent was into a Paradise that omprised the world. Adam and his wife became established, nd their children increased and multiplied over the fair garden, n the midst of plenty, and in time began gradually to people the and; but the race then—who we presume were endowed with ntellectual faculties little if anything inferior—were like their modern posterity, incapable of improving except from necessity. Under such a state of things, in an Eden where nature provided or all their wants, there were no impulses pressing them to mprovement, hence these, the descendants of the first man, like he men of our time, finding the bounties of nature supplied their wants, stood still, and contented with plenty, led an indolent xistence. They no doubt pursued their game with spears and rrows, and by a miserable system of culture scratched up the ground, for they had the advantage in their purer atmosphere of o possible failures in their crops, and knew the exact measures f produce they would yield. When they had performed these rimitive routine of duties, they did all that was imperative; and hus, in the enjoyment of unfailing abundance, they, the same as he highest races of men now in the world under similar condiions would do, passed unprogressive lives in indolent enjoyment —standing still, there being no necessity upon them to invent, mprove, or march forward.

We are not speaking of the antediluvian ancestors of the other ontinents, but of our own Asiatic progenitors, who we presume ossessed then as we do now the talent and spirit of progress. They neglected their opportunities, for in their earthly Paradise he impulse was wanting; and such is the lowness of the highest ortion of our planetary race, if the same condition of things now xisted, that even our boasted English with all their development, f any uncultivated fraction were placed in the luxuriant plenty we ave fancied, would never improve, but remain at the same tagnant level for ages, till at last some fearful retribution would vertake them through their neglect of the opportunities which God had given them. This was actually the fate of our fathers before the flood, followed perhaps for ages by terrible sufferings, wholly brought upon themselves by their persistent neglect of the alents that were bestowed upon them, by which in the end they nd their posterity might rise step by step nearer to the Eternal.

Man, when first created, must unquestionably have been lord and master of all other creatures, for nature, which is another name for creative wisdom, does all things well. Hence, the first duty imposed upon him in coming into the world was to be its master, and out of the confusion of universal irrationality that previously existed to reduce all things to order. He and his posterity of course continued by their rationality to be the rulers of the world, but unfortunately he stood still while other creatures continued to advance. He, as a responsible being, may improve or may not, for all his acts are voluntary. If he makes no advance, he must stand still, and thus rebel against the laws of nature that have ordained all things to advance and improve; but human advancement is not in the body, but in the mind. Beasts improve physically, men mentally; it is voluntary with the latter but involuntary with former, for being irrational they are irresponsible, and nature does all things for them. Every improvement, on the contrary, in man is an act of his will, and if he stands still and refuses to improve, his mind becomes stagnant; he constantly loses ground compared to the beast, and goes relatively backwards, while nature, at least to a certain class of beasts, is slowly adding to their strength and proportions as their generations follow. This is the condition that existed relatively before the flood betwixt man and beast, and it is the same still, for many species of beasts are imperceptibly gaining in size as time progresses; but to meet their increasing strength, human invention in these days enables us to hold the supremacy.

In the days before the flood, as already observed, men luxuriating in the midst of natural abundance refused to invent or advance. They felt no necessity for it, while in the meantime, perhaps for long ages, the beasts of prey, the only enemies he had any real cause to dread, were growing bigger. Yet long after they became formidable from their increasing strength, men continued to be their natural masters, in a limited sense, while their habitations were safe strongholds; but in the course of still longer time, hyænas, bears, and boars, with many other monsters, had attained the size of horses and elephants, some of them swifter on foot than the fleetest racers. Against these devouring monsters the strongest habitations then built were no protection, for they at last had become powerful enough to demolish them to shreds and crunch up the inmates. There was nothing left to save the human race —at least in this division of the world—from extinction, but the miserable alternative of abandoning their dwellings in the open, and descending into caverns underground, with inlets too narrow for their devouring enemies to find entrance. In this mode of life—besides the sufferings it entailed upon them during the times they were forced to hide in these their only places of safety, they might for any length of time be guarded by the monsters lying in wait without, and thus kept from communion with the outer world till death in their damp slimy recesses put an end to their misery. Our ancestors' necessity having at last become the mother of would-be invention, they might have been equal to the occasion, were it not that the monsters now became masters of the open, prowling about in hundreds, and thus all communication by land being cut off, human advancement in the future became impossible. When outside, they had to be within running distance of their caverns, to be farther away was venturing on the risk of certain death, for one or more of these irrational giants were sure to be not far off, ready with bounding strides to fall upon and devour them. This is the brightest view we can take of the terrible condition they were reduced to; but we can well imagine the state they were in, when their four-footed enemies were prowling in close vicinity for perhaps weeks at a time. Most of us know something of the privations which the modern hermit voluntarily imposes upon himself, but his condition is vastly preferable to the abject wretchedness of the man and his family before the flood, or most likely several families huddled up together in their dismal dark cavern, shut out from the light and air. The family or families at the times their monster enemies were at a safe distance would come out and bask in the sun—for we suppose under their pure atmosphere there were no clouds, and therefore constant sunshine—round the entrance of their cavern, and thus occasionally by stealth enjoy the fresh air and inhale new vigour to continue their wretched existence below, and at the approach of danger to run under. The labourers would likewise, from necessity, sometimes venture out during the day with their rude implements of culture to scratch up the soil and plant or reap their crops. They had to proceed some short distance from the entrances of their cavern, but the small area cultivated with safety could not have been much farther than a stone-throw within a circle of their hiding place. Even that, under the fearful condition they were reduced to, would likely have been impracticable without the faithful dog, trained to look out for danger, and on his giving the alarm they had time in most cases to escape into their retreats before being overtaken by the bounding fleetness of the hyæna. This state of rule by the irrational giants that everywhere prowled about in those days, did away entirely with domestic animals, so that in addition to cultivating the patches of ground, as described, they had the hardships imposed upon them of procuring animal food by killing or ensnaring wild animals. They could not follow such pursuits in the open, or they would have been eaten themselves; they therefore had to mount high trees, at as safe a proximity to their caverns as possible, and lurking out of sight from limb to limb, by this mode of hunting they killed or tried to kill whatever birds or small beasts might come within their reach; for we suppose from the abounding richness of nature at the time, living animals were in the same degree numerous. The implements and weapons they performed these feats and laboured with were not of iron,—for that they could not under such a condition of things possess,—but fashioned out of stone or flint; and for this reason geologists call it the age of stone, and no doubt they were of the identical patterns of some of the implements so often found imbedded in the drift.

In such an unnatural state of things, when the world was subject to the government of the brute, the lives that men were forced to lead were subjected to a variety of vicissitudes—at times cultivating their patches of ground, a greater portion of time upon the trees in the open air, and during their hours of leisure they most likely resided in houses, such as they were, erected around or over the entrances to their caves. Within these, in which they and their families for the most part remained, their safety consisting in the unbroken vigilance of man and dog, and whenever the alarm of danger was sounded the families of course scampered for safety into their common hiding place. These cavernous dwellings are therefore to be looked upon, not as places where they cooked, ate, and constantly lived in,—for cooking in caverns without top-vents was impossible on account of the smoke, and people continuing for any length of time in such places would soon die out for want of fresh air,—but refuges to escape into during the day or night when the destroyers were near; and there is no doubt they had a breed of dogs trained to look out for danger at all hours of the day and night. But this condition of things—the order of nature reversed—brought about by the perversity of man, could not last for ever, and had to be corrected by the judgment of God—no doubt by natural means, for nature performs all His wonders, but yet Almighty design becomes clear in the results produced. The avenging angel, the comet, as already described, drove the oceans over the land, destroying most living things, and among them leaving not one to escape of the brute-giants of those days that previously held sway. Almighty wisdom so ordered it that a few individuals of the different races escaped, not to continue and increase in the Eden they were just turned out of,* but under a new atmosphere, in which they could breathe and live as before. It was rainy, fitful, and tempestuous, inflicting an amount of privation and suffering just sufficient to incite at least the highest types of our race to invention and improvement to meet the necessities brought on by the great change, and thus to gradually rise, which during the antediluvian epoch they were incapable of doing under a purer clime that we take to be the Paradise of Genesis.

Previous to the flood, there were other dwellings of safety besides caverns resorted to, but before describing them we may observe that if the antediluvian features of all low lying lands followed the conformation of the underlying rocks, if shovelled out and laid bare,—and the moulding of the scenery could not have been widely different,—it is unquestionable that as so many depressions are below the sea level, small lakes or lakelets innumerable dotted every landscape. These were nearly all filled up with the flood, and are at present, perhaps, sometimes the sources of our artesian springs. But letting that pass, the dwellers on the shores took advantage of these lakes, and by means of piles driven into the mud erected villages upon them. In these villages, all the littoral inhabitants were enabled to dwell in safety; for however powerful the beasts of prey may have been on the land, they were entirely at human mercy in an attack from the water. Yet this system of lacustrine villages could only have been asylums for fishermen, or people cultivating the land at or close to the shores; for those who had to seek a living at any distance could not avail themselves of them, without the risk of being devoured in their daily journeys to and fro. The consequences were that all people dwelling not within a short reach of sheets of water had to put up with the more dismal condition of part cavern life, except that there might have been isolated rocks the great monsters could not scale, on which, no doubt, villages of safety could have been in like manner erected. Such detached natural strongholds are certainly very rare in the world at present; but in those days it was very different before the ruggedness of nature was smoothed down by the flood, and all rendered comparatively flat and tame by its sweeping force in filling up all unevenness by the drift.

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* Every idea in the beginning of Genesis has a purely figurative meaning, strictly true, but at the same time incapable of literal interpretation. They were turned out of the garden, not in their own persons, but collectively in the men and women of their posterity. They long continued to eat the forbidden fruit of indolence and pleasure; beauty tempted men, and, figuratively, Adam and Eve both ate of the fruit and fell, and were universally turned out of the garden. The giants of those days were the cherubims and flaming swords that turned every way, and destroyed all those without mercy who ventured into the garden. All communication by land over the fair Eden was cut off, and men, as described above, had to live and die on the spots surrounding the caverns where they were born.

The cavernous hiding places of the time must have been, at least in number, equal to hold all the population who lived inland out of the reach of lakes or sheltered bays. We also suppose that, although they could have had no intercommunication by land, population was everywhere comparatively dense, for on account of the devouring monsters there were no wars to keep down natural increase, as was the case after they had increased to the tribal state in the present era. But even independent of this view of the question, the thickness of population then existing is proved by the great number of flint instruments found in the gravel, nothing as compared to what really would be discovered if all the drift deposits were searched. These instruments, so numerous, were only the stock in use at the time. If the tools of trade were numerous, so must the people have been in the same ratio to whom they belonged, and as all, young and old, living inland from sheets of water, were no doubt provided to save their existence with cavern room, the caverns themselves must have existed over the land in thousands. We, without any practical knowledge on the subject, are inclined to divide these caverns into two classes—namely, those that were hollowed out of deposits, and others which were scooped out of the rocks. If there were any of the former—and it is probable they were much more numerous, as their opening in those days with the tools then in use must have been a great saving of labour—the flood has undoubtedly destroyed them all. None of them can, therefore, be left to bear witness that they have existed; but with regard to the rock caves, the flood could not have obliterated many of them—at least a majority may have escaped annihilation—it is therefore possible that countless thousands of such recesses exist over the continent, concealed out of sight in their original perfection. If they exist, Where are they? Before the flood they were universally common wherever population had to be protected; but nearly the whole land is covered over by the drift, under which the greatest number of these caves lie, and from their deep and uncertain positions it is only on the few rocky rising grounds which crop out of the plains that such discoveries in the future are, for the most part, likely to be made. But, even on these hills—and we think there are very few rocky rising grounds without them—their entrances are silted up by the flood and other causes, so that there are no external marks left as guides to them, and it is only by mere accident that an odd one now and then is stumbled upon, principally through the labours of the quarryman. Then, if we compare the extent of rock pierced by industrial pursuits with the whole face of the country, and the number of Adamic caves thus accidentally hit upon, we may very reasonably conclude that, as the total proportion of rock-formation thus sunk into is insignificant, many thousands of these caves exist in their original perfection, unknown and out of sight, under the rocks of the low-lying districts of our country, excluding those, in vastly greater proportion, contained in the rocks covered with the drift. Just in the same degree as they were numerous, so must have been the population before the flood.

As to lacustrine villages, although they must have been common wherever still waters of any breadth were to be found—and the natural conformation of the underlying rocks underneath proves that lakelets were vastly numerous—the force of the deluge had a more universal effect in obliterating every vestige belonging to them than on the caves within the rocks, so that we must expect their remains to be few; yet in any particular lakes protected sufficiently round with rock barrier—and many small lakes were thus surrounded—the villages erected over them were of course destroyed, but the remains of the piles on which they stood may, in many sheets of water thus protected, be in part still preserved. But nearly all these small lakes being necessarily filled with the drift, except that coal-shafts or artesian sinking might some time or other drop down upon the piles of the covered-up lacustrine villages, there are but very faint hopes of any such discoveries. In some existing lakes, however, spared from being filled up by the flood, the piles which supported the villages are to this day in a wonderful state of preservation, and spread over areas wide enough to prove that they included large populations.

e public-spirited individual would only drain out the water of these Swiss lakes to the proper level, he could fill a n with antediluvian relics, and scientific knowledge would be worth a hundred times the outlay. Everything heavy within ouseholds when destroyed fell to the bottom into the mud, uently all weighty articles not perishable which they pos- are lying down undisturbed, perhaps in almost as perfect a s at the first. Their earthenware would inform us how far eramic art had progressed, and the great collections of flint r implements that would be recovered might let us into a dge if any of them were fashioned for war, or only for the r agricultural purposes; but this last is improbable, as hard vould be more useful for the purpose, and being light, the carried them off. At all events, their cooking utensils, we suppose to have been of earthenware, would enable us to whether or not they partly subsisted on the products of the nd amongst the miscellaneous collections, certain tokens indicate if they possessed any knowledge of a written ge, or some of the ornaments that were sure to adorn their s might likewise be found. Nothing made of metal would covered, for as all land communication was cut off, it is ible they could have possessed metals; but viewing the altogether, the treasures contained in the mud of one of acustrine cities would prove, notwithstanding that it was of ty the age of stone, that just before the flood they were dvanced than modern philosophy gives them credit for. ad no metals, for if they had even known their use they ut off from their supply; but it is possible to make some es without the use of iron, if we take the Mexicans as mple. When America was first discovered, it was found that exican portion had made considerable advances on the o civilisation, and, excepting gold, they were untaught in etals; besides, we must bear in mind that it is our own ean ancestors we are here reasoning upon, undoubtedly hen a more highly gifted race. At the time of the flood, er, they had reached a certain level in civilisation, the late ties of their situation forced them into it. They found, t was too late, that they would all be eaten up if they con- in their then abodes, and this perhaps was the first time he earliest manufacture of their spears and arrows that the ity of invention was forced upon them, and that so strongly eir very existence depended upon a change. They, as escendants are at this day, were equal to the occasion, and that even then they possessed the inventive faculty in as degree as their latest posterity. Some of them first found iding-places in natural caverns, which at once struck them ne necessity of subterraneous shelter on a more extensive The want was an indispensable one, and just at the right like all great inventions, a bright genius sprung up and them, by some art now unknown, how to scoop out their hiding-places in the rock. Again, the dwellers on the borders of lakes, which we suppose were then very numerous, now discovered that they were safe from the attacks of their irrational enemies when out from the margins in their canoes, and the thought struck them that if they could but live on the waters in times of danger it would be more comfortable than their damp caverns and equally safe. Here a most pressing want arose, in a shape to be indispensable, and invention, or rather inventions, quickly followed that enabled them finally to fell trees and cut them into lengths, point the logs, and drive them into the mud to the required level, on which they erected towns, no doubt of several stories high—so costly foundations were never made to support humble huts—and large enough for all the shore population to dwell in. These works, which even now would be considered great, the inventive genius of the time created, and, everything considered, places them on a natural level with the ingenuity of our times. These great works they must have performed—that is, hollowing the solid rocks out for habitations, and building their villages on piles—by some arts of their own invented for the occasion, that none of their descendants since the flood have yet known. Their stone implements prove that they had no iron, and without that article it is beyond our conception to know how the works were done. Let us for instance suppose, by way of example, the world to be suddenly deprived of the use of metal at the present time, but that we should still retain an understanding of all our arts and inventions, if the imperative necessity was imposed upon us of cutting out our habitations in the rocks, and building our cities on the waters, where would we be? Even as it is, such grand engineering feats would be our pride and boast; but without iron, with all the inventions and knowledge now in the world, we should be unable to do such works. The works, however, are there, and still remain with us, speaking for themselves, as imperishable monuments of art handed down to us. One important fact is thus established; the latter part of the Adamic epoch which we, on account of their flint implements, look down upon with pity from our proud eminence, may perhaps have been in a civilised state much higher than is generally supposed. A people who, without the use of iron, could build their cities on the waters, and hew their dwellings out of the rocks, notwithstanding that they lived in the age of stone, are not to be despised.

CHAPTER XXII.

THE DELUGE.—*Concluded.*

THE antediluvian dwellings, whether lacustrine or cavernous, existed in number and capacity, wherever there was population, sufficient to give shelter to all the inhabitants. The former were adopted from necessity by all inland people removed any distance from still waters, and were likely much more numerous, all isolated by themselves; and the latter, being the most comfortable, were used as dwellings or cities of refuge by all littoral populations, whose industry was on the lakes or close along their shores. As monuments of a bygone time, taken together with the known co-existence of the irrational giants, the purposes of such strange abodes are as clearly demonstrated as if it had been our lot to live amid the scene; and here it may not be irrelevant to observe that the existence of these dwellings, especially the lacustrine, is only of recent discovery, and, so far as we are informed, they are all considered as having been places of safety from human enemies—the caverns as being impregnable, and the villages as unapproachable strongholds on the water. This is just such an idea as would come from your true philosopher; his conceptions are often sublime and grand, but seldom practical. The military man whose study is attack and defence would scout the idea, and point out that in presence of a human enemy these retreats would only serve as traps for their own destruction. The invading enemy would only have to close the mouth of the cavern, always narrow, and choke the helpless inmates for want of air, or he could employ the other alternative of asphyxiating them by the fumes of smoke; while a lacustrine village, several stories high, closely built together and composed of highly inflammable materials, could easily have been approached at some unguarded spot, stealthily in the dark. Thus the hostile incendiary, with his simple firebrand, would be enabled to burn down the whole village with its inhabitants, nearly all perishing with no hope of escape; for their enemies would be so posted as to bar their retreat to the shore. This mode of living would have been impossible had there been any human wars at the time, for all the caverns and towns would only have been, as before observed, traps for their own destruction. In short, all the world had to be at peace, for no forces could come into the field; but they had one great enemy in common, the overgrown brutes that were lords of the creation, and all the dwellings of the time, whether isolated or in towns, were most effective and impregnable strongholds against their irrational fury.

These strange abodes, however, certainly existed in that age, for some of their remains are still with us, most likely being then universal, and for dwellings to be either cavernous or lacustrine and universal, some very powerful cause must have operated; for, except hermits, no nations or races of men in any age or time ever existed that voluntarily adopted such a condition of life. It proves one thing, that there were no wars at the time, or the wooden cities on the waters could not have existed. There was, therefore, some pressing danger, without any other means of resisting, that drove all this part of the world into such miserable retreats, and whatever it was, it must have come from either man or beast. Their caverns and lake villages, as already observed, could not have been a protection against man, and it only remains that they were asylums of safety against the devouring giants of the time, in all respects safe retreats from their attacks, and without their protection the population in all parts of the world over which the monsters roamed would have been annihilated. Here is therefore the true solution of the people of that time being either forced to submit to gradual extinction by the giants mentioned in Genesis, or, as the only alternative, to frequently live and sleep, and very often die in their slimy dens of retreat. The picture is not drawn from imagination, but from facts. We have the bones of the giants, the skeletons of men, with their stone implements in vastly greater proportionate number,* all mixed in common in the drift. The evidence is completed by some of the caverns left intact on the hill sides, and the foundation piles of the towns that rested above the waters of sheltered lakes, undoubtedly of the same date, giving us a wonderful insight into the then condition of the world, with no doubt a comparatively dense population, but the order of nature reversed in brute force obtaining the mastery over mental supremacy.

According to existing philosophy the extinction of the giant races of animals was a gradual work, the effete or worn-out species giving way to the superior, as the world and everything in it continues to progress. This natural progression is in a certain sense true; but as regards total extinction, species have never yet been known to vanish out of sight without their means of living were cut off, or some force or forces applied to produce the result. There are, for instance, several species of animals gradually becoming extinct in our own time, but in all these cases there is an exterminating force applied by human prowess, and as it is constantly extending itself, there is little doubt but that the large carnivora, such as the lion and tiger, the wolf, bear, hyæna, leopard, and all such of respectable size are doomed to early extinction. The causes which are hastening their extinction in no respect apply to the antediluvian monsters that once prowled over and ruled the world. When they existed, there were no artificial forces invented that could fatally act upon them, with perhaps the single exception of cunningly concealed pits, and as to the means these creatures had for existence, if our supposition on the subject is true, nature on the average produced a four-fold greater abundance for them to live upon, and their very existence argues that there was a vastly greater plenty than at present; yet even taking a matter-of-fact view of the question, that the earth then was no more prolific in production than now, the supply in either case being equal, the exhaustion of food could not have been the cause of their extinction. It must have been some superhuman force, acting universally upon them, that blotted every living vestige of these giant races out of sight. We are to keep in view that the annihilating force fell, not only on one, but upon every species of the enormously overgrown animals alike; they were all without distinction swept away. Their total extinction cannot therefore be otherwise accounted for, except we arrive at the absurd conclusion that they as worn out and effete races ceased to procreate, a sudden or rather gradual increasing barrenness that we suppose never yet overtook any species of living beings, either then, since, or before. As therefore all the races of enormous size without exception ceased to exist, not one species being spared, and as no human force was at that time strong enough to destroy them, nor any natural operations at work that could have brought about their extinction, while a remnant of all the smaller races survived—as a chain of facts these go to prove that the exterminating force must have been simultaneous and universal. If it had been partial, such as a geological change, they would have been spared in one part of the world while destroyed in another, and thus down to our own times have continued to be the same universal scourge; or even if the great calamity had not overtopped the highest mountains, some of them might have been left to propagate their kind. But we repeat, the visitation spared not a spot on the world,—not even the tops of its highest mountains,—and no other natural calamity could have been thus universal except the visit of a comet with its inconceivable velocity striking the earth, driving, by the sweeping force of its atmospheric matter, the oceans over the continents, submerging temporarily out of sight the dry land, and thus quickly destroying nearly all living things. Amongst them not one of the giants could escape—they were too unwieldy to withstand the buffeting force of the raging element, and were all destroyed.

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* In the drift deposits of the flood some odd animals got buried, but being of lighter material they were nearly all swept by the retreating waters into the sea, or left high and dry to decay out of sight, whereas the implements of stone, if free from wooden handles, being of the same weight were mostly buried in common with the drift. This therefore accounts for so many of the weapons being found in the gravel, and the paucity of human remains in the same deposits.

We have repeatedly observed, that every mountain top in the world is left bare and shorn of all prominences that the swe the flood was strong enough to level; and the same holds good on all islets of the sea, and the portions of sea-coasts which slope down to the waters. Every little isle—with the exception of natural deposits since the flood—is found to be bare from the event, and wherever there is a sea-coast, that portion of the land which slopes down without a break is likewise bare. Thus we have three of the most imposing features of the globe, islets, sea-coasts, and mountain tops, all giving overwhelming silent testimony of the great event; for in such places, while there are natural deposits, and in depressed spots no doubt some of the old antediluvian detritus, there is a total absence of drift. No brown sands, no gravels, no pure clays free from the natural pebble mixture are to be found in such places, and why? Because the mountain tops and islets of the sea were exposed so prominently to the sweep of the flood, no portions of the drift could settle upon them. At the time they were all left bare, bald, and naked, except perhaps some of the old deposits lying in fissures and the deepest hollows, and it is much the same with the sloping margins of all sea-coasts. The retreating floods from the submerged continents, descending in all directions with sublime fury into their ancient beds, left the sloping shores down to the waters shorn of their weaker cliffs, and bare; and it is in vain round these borders to look for any of the washed debris of the flood, as all such materials were swept clean into the sea by the descending torrents. These facts, as universal proofs, are common not to one but to every portion of the world where mountains exist and land and water meet, thus bearing universal testimony of the great avenging event, the presence of the flood. When we go inland from the shore we find the effects produced are in all respects different. As the grand panoramas were suddenly invaded with the sweep of old ocean, in a few hours it overlapped the highest mountains, tearing up as it raged along to the bare rocks the natural deposits of a hundred thousand years, mixed indiscriminately with the gurgling element. The waters had soon to return from whence they came, and in their retreat there were eddies where they were temporarily still, or tracts in which the churned-up mud washed out of the disturbed deposits settled down into beds of clay, leaving all the other materials, consisting of the minerals which make up our brown sands and gravels, in about equal proportion—it is not often that they are distinct and separate *—settled down in positions where the retreating currents were strongest. In a few days at most all was over, leaving lowlands, deprived of their native ruggedness, tame and comparatively level, with hill and

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* Drift-sand is generally more or less mixed in about equal proportion with the coarser minerals termed gravel, but in odd spots over a district of gravel deposits, there occur isolated undulations of pure brown sand, slightly intermixed with small pebbles, but generally of very limited extent. It is possible that these patches of sand may have been collected together and separated from the gravel by whirlpools, which must have been very numerous in the waters of the flood.

r natural to the sudden settlement of the surged-up material. naterials themselves, wherever they may be, and they are or less common to the whole world,—the sea-coasts and the)f the higher hills and mountains excepted,—fill up the :s and fissures of the old world. They can always be known ng of one hue, and to have been subjected to a violent ıs of washing. They are not waterworn or bleached white, proves the operation to have been short; and the effects universal, they could only have been produced by the of the oceans over the land. No other waters could have equally and produced the same identical effects over the surface of the globe, nor is there any material force in , whether in the heavens or the earth, that could have up the oceans out of their beds, except the raking force of et, with its immense and highly condensed body of atmoc matter, striking upon the earth with its well-known velocity. ard to the drift deposits covering over the lowlands and ıg out its ancient ruggedness, it may be asked, Are all concealed by the washed stuff? By no means; for low hills more or less abound over every champaign country, ı these modest eminences, the washed materials of the flood, .s sand, gravels, and pure clays, are seldom found, and only tural deposits of the last few thousand years. They were the ıt prominences of the scenery, and as on the higher mountains, ırgins, and little isles, nothing could settle down, for all was clean off into more depressed places. Thus, wherever n, overwhelming and universal evidence is given to us of luge.

have set out with the broad assertion, that there is not a f dry land on the surface of the globe but gives its quota of ıce as to the reality of the deluge, and everything that can ıas been advanced confirms it as a truth—all direct evidence. ay now descend to the sea-coasts for other direct evidence :he time of the event, which at the same time will indirectly its reality, by the marine deposits which have taken place :he wear and tear of the land since the event. That a r conception of these recent deposits may be had, let us 'e that all streams of fresh water which discharge into the ıve their respective deltas, from the trickling streamlets to ·gest rivers, and these deltas are large or small in proportion size of the rivers to which they owe their formation, and ;es of the continents or islands from whence the rivers ıd. The deltas of the greatest rivers, such as the Nile, the), the Ganges, or the Indus, are each large enough to be s in themselves, and they are all as well as other large divided into two very unequal parts—namely, a fringe of a ı depth of sand-hills or rather hillocks blown up into heaps : wind facing the sea, and the remainder, the much larger rtion, perfectly flat plains, generally of the richest fertility. uth America these formations take up at least half the continent,* and are bounded, round the whole Atlantic frontage, by the usual fringe of sea-sand hillocks miles in depth, much the same as we are all familiar with at the outlets of our British rivers on a smaller scale. These characteristics being common to all deltas of any extent, the question arises, Why are they smooth and flat inland, and deeply bordered by dreary sand-hills facing the sea, seeing that the same operations continued to form them from the beginning throughout? The sweeping force of the deluge unravels the mystery. Before the event, the total expanses of the deltas were endless dreary tracts of sand-hills—but if the climate, as we suppose, was a Paradise they were all fertile—formed during the long past throughout, just as they are now, by being raised by the surging waters on the shores. But when the oceans were forced up in bulk over the land, besides levelling many of the little rocky hills and washing away every vestige of volcanic eruptions, the mounds of loose sand that were heaped up through long ages on every coast where rivers emptied—and that embraced the deltas throughout in endless sand-hills—all melted away before the invading force, and the wide expanses were thus flattened down into the fertile plains they still continue. As the flood subsided all sea-coasts and deltas were therefore denuded of their sand-hillocks, so that those which now fringe the shores are the materials brought by rivers into the sea since the great event at the beginning of our era.

It is unquestionable that it is in the age since the flood that all the mounds of sea-sand began, when we study everything connected with them, and especially the relative proportions of deltaic formation belonging to streams respectively, all as facts relatively compared giving us convincing evidence that the bulk of sand washed down is about what we might expect in a few thousand years. A reflective person, for example, sauntering along any sea-shore, if passing over a tiny brook rippling from the land, will perhaps see from the features of the surrounding hills that it drains about a square mile of country, and he would be sure to find at the mouth of the streamlet a little strand of white sand, backed by a narrow fringe of sand-hillocks, frequently alive with a colony of rabbits. Judging the total deposit, he would easily come to the conclusion, from the natural operations at work, that the sand on the strand and hillocks is just about the quantity that the little brook might have been enabled to bring down from its mile of ground in a few thousand years. In is [illegible] ment of [illegible] it its [illegible] has [illegible] would [illegible] of [illegible] deposit as [illegible] at the [illegible] wandering [illegible] would [illegible] flat and [illegible] of the [illegible] formed before the flood, [illegible] the sea is the same [illegible] All the flats as far as the rising ground [illegible] a continuation of [illegible] the sweep of the deluge naturally mantled these loose formations out of sight, leaving all flat, smooth, and fertile by a superincumbent coating deposited over the surface by the flood, while the sand-hills on the foreshore are of postdiluvian formation. We are therefore to look at these sand-hills as measures of time since the flood, and the extent of those flanking wide deltas as guides in the same direction, after making due allowance for the sand drifted in by the wind over the antediluvian flats. Taking all these facts inclusive—for they are the true features of river deltas and sea coast sand formations in every part of the world—they, in a striking degree, confirm the reality of the deluge, and that the event, geologically speaking, must have been recent.

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* Wherever in any part of the world, whether inland or otherwise, dead flat lands are found on river levels, they are sure to have been formed in past ages by the rivers that pass through them. South America, from the lowest rising ground of the Andes, is in flatness all over an ocean surface, is on the same level as the Atlantic outside—at some places a thousand miles distant—and the great rivers which cross the wide expanse are all on the same level. These facts show that the immense ocean of flatness is one great delta, besides proving the antiquity of that continent as being far ahead of any other division of the world.

If we descend to other particulars, the deluge is established by an endless array of facts, it may be some cases isolated in themselves, yet when taken altogether they place the event beyond a shade of doubt. Could any proof be stronger than that the bodies of the different races of animals, and man with his stone implements, are all mixed together indiscriminately in the drifts, in themselves stamped with all the self-evident features of one grand decisive and short operation. Next, we have the evidence of the smaller races of animals found in the same drift, still by their offspring inhabiting the world, while the giant monsters all perished, not one being spared to continue their species. Inevitable destruction was the doom common to them on account of their unwieldy frames, while a remnant of the smaller races escaped, as the raging of the waters could not for these reasons be fatal to their total extinction. Again, the final link of the chain of evidence is the habitations still left us, which, taken together with the surrounding circumstances, establish as clearly the purposes for which they were constructed, and the uses these Adamic abodes were put to, as the buried ruins of a great city tell that it was once a thriving capital. The remains of the men and monster beasts are there, swallowed up together, they therefore must have lived and died at the same time; and the habitations left, prove that they must have been constructed with the sole view and no other, as the only possible protection available against the devouring enemies they had to guard against. Nothing could be stronger evidence than the men, the beasts, and the strange abodes, all existing—at least the men and beasts must have co-existed, for they are swallowed up together in the same drift, and the fact of both dying together, they necessarily walked the earth previously together. This clearly proves the contemporaneous use of the habitations, for without them the human race long before would have been annihilated, being at that time possessed of no weapons which could act fatally upon their irrational enemies, and as all communication by land was cut off they could not better their defensive condition.

In the first part of our subject, we gave our reasons for the beginning of our era being much about the time pointed out in the Mosaic account, by tracing back the earliest nations to their origin, and that in the then existing state of the world no other nations could have preceded them. The first invention of letters, —an invention indispensable as nationalities accidentally rose,—and what we can glean from the earliest dawn of history as to the thinness of population in lands known to the authors of the records at the time, clearly sets the question at rest that the nations mentioned in the Bible were the first that existed. But however conclusive the facts may be, the evidence of the prehistoric period from the flood up to the invention of letters, is, as to time, clouded with a vague degree of uncertainty. Happily, however, the uncertainty is removed by the antediluvian abodes, for their existence and the relics belonging to them, although they point out no exact time, give us the clearest and most direct proof that the flood, at whatever time it may have occurred, must in a geological sense have been a very recent event. The piles on which their towns were erected are still standing in a tolerable state of preservation. Now, although pure water in one sense will preserve wood for ages, yet, so far as these piles are concerned, there are operations at work, principally the surging friction of the waters, which would long since have eaten the last vestige of them away, if anything like a geological epoch had intervened since they were placed; and taking them for what they really are, antediluvian relics still preserved, without other evidence to the contrary we would be inclined to think the flood was much later than four thousand years ago, were it not that we have such universal proof that it must have been at least that far back. Viewed in any light, however,—in the examination of the piles as the spared vestiges of the flood,—there would be none of them now left as witnesses of the event had it taken place much earlier than the time recorded. Nevertheless, should it be considered that the piles, notwithstanding the action of the water, would continue preserved for almost any length of time, we have a still more convincing proof, of the lateness of the flood in the contemporary cavernous retreats, not in the caverns themselves,—for some of them are likely to last as long as the hills they are scooped out of,—but in the gnawed bones still in a state of preservation within them. Bones, it appears, will keep an immense period of time before they become entirely obliterated by gradual decay, but it need hardly be observed that, unlike concealed stone, they are not imperishable; yet they still exist in these caves as remnants of the food the miserable inmates at times were forced to live upon—the strongest possible direct proof that the account given to us in Genesis of the flood in regard to time cannot be far from correct.

As far as we are aware there are few cooking or other utensils, such as earthenware, found in the caves, and if this is generally so, and it is extremely probable, it confirms our idea that they were not permanent dwellings but refuges to run into from their fourfooted enemies; and most likely the houses or huts they generally lived in during the day were erected round the entrances of their caves, each cavern, probably, the joint property of more than one family of the same kindred. The bones themselves found within these retreats give no proof that the inmates lived entirely on animal food, which would be quite opposed to the habits and tastes of their descendants, but that they were forced to exist upon these joints—no doubt carefully stored below for the purpose—during times of danger. Thus, when any of the prowling monsters made their appearance, if possible stealthily to devour them as their prey, whenever the alarm was given one and all quickly escaped into their asylums of safety, where they had to live upon the flesh, raw and preserved, for cooking in the caverns on account of the smoke was impossible. So long as the danger lasted they had, without moving out, thus to continue living, and the periods of their imprisonment were no doubt often very much protracted; for the unwearied patience of beasts of prey lying in wait is a well-known fact in natural history,—and cat-like they may often have crouched in silence near these subterraneous dens for days together. During these intervals their only safety was to be concealed within, supporting life as they best could on the animal food, that, no doubt, was always kept stowed away for the purpose. We cannot think that their caves in ordinary times were used as sleeping places, but rather that they braved all danger by sleeping in their huts, men and dogs keeping watch by night to give the alarm of approaching danger; or if that, consistent with safety, was impossible, rather than have their lives cut short in the midst of such slimy dampness and want of air, it is feasible they may have erected covered sheds on the boughs of the trees, up which at the approach of darkness they ascended to safe healthy sleeping places, for at that time agility in climbing must have been a universal accomplishment.

CHAPTER XXIII.

GROWTH OF THE EARTH.

LOOKING up to the heavens we behold a thousand suns, and in the intervals betwixt them we know that there must be millions of sunlets and worlds which, from their comparative insignificance or opacity, are invisible. The first thought which occurs to the reflective mind, is, How came they there? when and from where? who is their Author? do they only exist for a time, or have they been from eternity? A numerous school of thinkers adopt the latter view, and that they will continue the same without change for ever. There they are, there they always were, and there they always will be. If they are asked, How are they there? Oh! it is chance! What gave them their wonderful motions? It is chance. How is it that all matter has attraction, a universal force which holds the materials of the worlds firmly bound together?—it must be chance. And the mysterious light that is everywhere in the presence of matter, and which continually enlightens the universe with glorious splendour, of course is chance; for it is the common title they give to all nature's productions, both in the heavens and the earth. We see the worlds held within their systems, instead of wandering at will; and the settled order, if broken through, would be universal chaos, yet it is chance. As a converse, the mighty comets, the grand messengers of life to the universe, while they are governed by the same laws as the planets, are held within no systems, but wander interminably. Thus, the same material forces and natural laws which keep the one class of bodies fixed, send the others wandering at random, through infinitely opposing principles equally indispensable for the welfare of the universe, produced by the same operations, yet in these sublimely wonderful works of Providence, they cannot see Infinite design. They blot out the word creation from their vocabulary, and if their teaching is true, the titles of this and the succeeding chapters would be misnomers, as creation itself could only be a myth.

There is another school, equally as numerous as the philosophers of chance, who believe that at a time far back the whole expanse of heaven was an empty void, and that the blackest darkness "prevailed over the face of the deep;" when, astronomically speaking, neither heavens nor earth, world, sun, or star existed. At last, by the fiat of the Almighty, "through Whom all things exist," the suns and worlds came into being in an instant of time, in all their glorious perfection, grandeur, and magnitude, clothed in the richest fertility and peopled with every living thing, both animate and inanimate. The description is sublimely grand and beautiful, and what is more, its leading ideas —all borrowed from Genesis—are based on truth. But we must bear in mind that the inspired passages, although they are in reality scientific, were never handed down to us for the purpose of teaching science; besides, they have been rudely tampered with by the interpolations of designing men, in an age when gross ignorance was all but universal, and when no critical eyes looked on to prevent them from adding to or taking from the original. And here we beg the reader not to include us in the ignominious list of unbelievers, if we fearlessly express our mind still farther on this earliest record of Hebrew literature.

When we view the sacred book as a whole, written by so many prophets, poets, and authors, appearing at times and places widely apart, yet all agreeing in the leading spiritual truths which they teach, we must conclude that the whole taken together is a collection of Divine revelation, delivered to the world by a succession of inspired men. It would be beyond the power of human genius for so many minds to have united at times so widely apart to concoct so great a fabrication in order to lead men astray. Even independently of the impossibility of so great a conspiracy, the Divine origin of the sacred books is established by their general, and in one sense, uniform style of composition, and by certain portions which would be far above human fiction to invent. The Apocalypse, for instance,—which still remains as great a mystery as when first written,—the greatest man that ever lived could not have invented; and the few simple petitions in the Lord's Prayer, if no such composition existed, could not be reproduced, or anything equal to it, by all the united theological scholars who ever lived if they were sitting in solemn conclave upon the subject. Lastly, the account of the creation in Genesis, although not given us for the teaching of science, has within it sublimely scientific truths strictly in accordance with modern discovery, infinitely above the reach of the greatest thinkers of that early age, or indeed of the present more enlightened times, to invent.

But while viewing and admitting the unassailable truth and inspired origin of the Scriptures as a whole, we cannot close our eyes to many fictions, or rather falsehoods, which frequently occur throughout the prehistoric portion handed down to us. We are, for instance, told that not only the world but all worlds were created in a single day, yet any one with a smattering of knowledge must know that such was not the case. Oh! but theologians will say, the days of creation were prophetic—a very elastic term, which might include six epochs of any duration; but any one examining the passage with the eyes of common sense must see, that whoever twisted the original into this sense, the true meaning he wished to append to the divine message—whatever the first sacred original may have been—was that the great work of creation took place in a time neither more nor less than a single week, minus the day of rest. Again, when we come to the narrative of the flood, the event itself, from the evidence still left us, is truthfully related, if it had been simply put down as such; but the author was ignorant of the natural force which brought it on, and being deeply cultivated in Egyptian learning, had to turn philosopher to explain the wonderful visitation. He laid it down as a truth to be taught to the world through all time, that the flood was swelled up by forty days' rain over the whole world to a level overtopping its highest mountains. Thus far the narrative is strictly true, except the part which accounts for the event by a visitation of rain, and this latter interpolation leads him another step still deeper into error. He had to explain how any living beings were saved during a deluge which lasted for months, by adding that a great ark or ship was built beforehand for the purpose, within which, two by two, all living animals were lodged in safety until the waters assuaged. The account of the ark, taken by itself, is in no respect irrational; but no ark or ship could possibly have been constructed to withstand the buffeting of the ocean rolling in bulk over the land; and as to a fresh-water flood on such a scale, it was impossible, therefore no ark was wanted to save a portion of the living from the universal calamity. Many other passages occur throughout the prehistoric narratives, which, besides being exploded by modern discovery, are equally improbable; altogether forming such a mixture of the sacred and profane, as to incline us to the presumptuous belief that the mediæval Church committed a great mistake in receiving these earliest books as canonical, and therefore infallible. Yet the infallibility of all the prehistoric passages, however absurd, is accepted universally in the creeds of all the Churches, and, whatever their private opinions may be, the learned divines in every part of Christendom must teach their flocks, at the risk of eternal punishment, to believe that the worlds and all things they contain were made out of nothing in six days, and that about six thousand years ago the earth was flooded over the tops of the highest mountains by a fall of rain. So long as such views are taught—or if they are not universally held forth in the pulpit, the prehistoric portion of the Bible is in every sentence included in the catechisms, which amounts to the same thing—there is not the least doubt but that believers will be constantly perverted by millions from the bosom of the Church. Let them only hold fast to these dogmas and creeds—and that they must do, for Median laws might change, but a creed once adopted can never be altered—children will implicitly believe in them, and some women; but grown-up men with the least knowledge of modern science, while many will try to make-believe and not absolutely run away from their Churches, in heart—because of the many passages in the first chapters in the Bible contradicting the truths that science every day mathematically demonstrates—they disbelieve the teachings, and all but in name have become the disciples of the philosophy of chance.

We will take a middle course, in submitting our humble views on the origin of the worlds, betwixt the orthodox teaching and the philosophy of chance. Our basis will be, that everything which exists had a beginning, and that while they last they improve on to greater perfection. The worlds, therefore, like other creations, began small and little, from then they continued to increase, and at the time we live in are constantly growing bigger. In other words, creation has continued from the beginning—we are in the midst of it, for we see it with our eyes constantly going on.*

Let us make the preliminary observation, that there is no sounder axiom in philosophy than that by changes which are taking place in the surface materials of the earth, into whatever new conditions they may be reduced, in quantity they can never become less. Hence, by every atom or particle the earth receives in addition from any source, it is just that much permanently enlarged ; and if the additions, however small, continue constant and have continued so from the beginning, if we allow a sufficient period of time, its enormous size, from the operations which are going on, can be easily accounted for. Now, aerolites are continually descending upon the earth, and it is incontestably proved that instead of being explosions confined to the upper atmosphere, as was formerly supposed, they fall into us from beyond, no doubt generated within the system, but coming in fair proportion from out of every part of space over which the attraction of the sun is predominant. They have continued to fall upon the earth in all times, since passing events were first recorded, no doubt in about equal number as at present ; for there is no period in the past in which falling stars, as recurring wonders, were not the common talk. Every one of them that comes down, the earth is just so much larger, and the number which descend in a single year is enormous. It is not only those which appear within view of the spot we live in, that we are to take into account, but the total aggregate which fall over every portion of the globe ; for no matter what part of it we visit, they appear with the same frequency, whether it may be at the equator or near the poles. As to their number, if we wish to form a rough estimate, going out of a clear night it is seldom that we would watch a single hour—and it must be borne in mind that the eyes can only keep in view one direction of the heavens at the same time—without seeing one, and perhaps more than one, of these meteors. They fall at all hours, both day and night, and at the rate of one an hour during a single year the total would reach eight thousand visible or within reach of vision from any one point of the earth's surface. They are supposed to appear perpendicularly about thirty miles above the surface of the earth. The eye, therefore, takes in a wide radius round which they are visible, from any standpoint. If we take the radius at fifty miles, which would represent a circle of a hundred miles in diameter on the surface of the earth, over which these eight thousand aerolites—visible from any one point—must yearly descend, and divide this area into the entire surface of the globe, we get the astounding answer that hundreds of millions of these meteors go to the enlargement of the earth every year! What may be their average size it is impossible to determine, for no one seriously reflecting on the subject—although it is the generally received opinion—would conclude that the odd meteoric stones which descend from them include all their material. It is well known that the smaller aerolites, the vast proportionate number, never, so far as is yet known, send down meteorites. What then becomes of the matter of this most numerous class? And from the larger ones the stones they do send down seldom exceed one or two pounds weight. Is it possible that a red-hot stone, of not more than three inches in diameter, at a distance of above thirty miles would leave a train of fire in its track, exploding with noises louder than claps of thunder; for even so far the explosions are sometimes audible, while thunder is never heard at half the distance? The one or two, or at most a few meteorites, can only represent an exceedingly small portion of the meteor; and that two or more sometimes come from the same aerolite is a clear proof in the outset that, previous to the explosion, they were all united in one, but under a very different condition.

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* The leading ideas on creation have been anticipated, in order that other subjects might be more intelligible. What is therefore to follow will be like a twice-told tale, for little that is new will be advanced. Nevertheless, we think tracing the orders of creation, however imperfectly, deserves to be treated separately by itself, quite irrespective of what we were forced to prematurely introduce in some of the earlier chapters of the work.

In partly investigating the nature of these meteors we will not go over old ground, by repeating what we suppose give rise to the formation of the stones which come down to us out of the materials of the aerolite. The latter, previous to its contact with the air, we look upon as a collection of matter fortuitously brought together through revolving motion, still in its pure atomic state, free from pressure to in any degree consolidate its matter, it being too small to be an attractive centre, without which pressure is impossible. The instant, then, that in its falling motion towards the sun the aerolite hits upon the terrestrial sphere of attraction,—as some aerolites in their descent to the sun must do,—its gravitating course is at once turned in a new direction towards the earth, and like all other bodies, besides the gravitating motion, it has also its revolving motion. With the force of its motion, its friction through the air causes instantaneous ignition and melts some of the particles, which in their dissolved state sometimes accidentally join and very soon congeal into the meteoric stones which descend, while all the rest of the aerolite is spread out right and left in a state of vapour—perhaps invisible—along the whole distance of its fiery track. In this condition, we suppose, nearly the whole aerolite is scattered abroad, which, unlike the meteorites, ke days and perhaps weeks before it finally settles on the l, for we are to look upon its whole matter as still in the tomic state. Let us therefore enquire, What in the creative is an atom?

finest dust of flour are not atoms, for the grains are sub- l and visible, and the smallest mote the microscope could visible is of immensely greater magnitude. If, then, we o define atoms, we would say that they are the materials which God makes men, animals, trees, vegetables, worlds, erything, in themselves small below what the imagination scend to, and can neither be seen, heard, nor felt. There aterial comes nearer to what we conceive to be the atomic tmosphere, but even it, although transparent, cannot scien- be termed atomic, for it can be felt; but if we descend water which evaporates in vast quantity up into this medium, ive us a clearer conception of the term atom. The evapo- ater, before it condenses into clouds, is totally invisible: w that it fills the air thickly around us, and there may be ss millions of the aquatic atoms in every square inch, but not even wet us, we inhale it in abundance by every we draw—and its admixture with atmosphere may perhaps spensable to our existence—but our thirst by the inhalation es unslaked. It is just such a state as this that we con- he atomic matter of the aerolite to be in when it is scattered force of the winds, or opposing atmosphere, into vapour invisible as evaporated water, where it hangs partly in se; but, being of a greater specific gravity than aqueous it requires no condensation to gradually and slowly settle Thus constantly and—with the exception of the meteo- mperceptibly and silently, this one, with millions of others, adds to the bulk of our world.

re do the atoms of the aerolites—the invisible but vastly proportion of their bulk—permanently settle down? ll on the oceans are held for a time in a state of solution, isible, while of that which settles upon the land a part no ecomes incorporated with it, but by far the greatest por- immediately carried also into the ocean. The atoms are eptible, and hang on every drop of water they touch. re thus carried hence by the rivers into the bosom of the n which they continue suspended just the same as the ted aqueous atoms remain also in suspense while uncon- in the air. Water, for instance, is much heavier than air, latter, at least that part of it below the altitude of the holds it up while in the atomic and invisible state, and, on e principle, stone in the atomic state, or rather in a state ible vapour, cannot sink, but remains, like the evaporated matter in the air, part and parcel of the water. We to think this may be the actual condition of the ocean; being stony matter, while in the atomic state out of the power of analysis to detect it. The most advanced scientist in the world could not detect water in the air, yet it is loaded with it; its presence cannot by any operations be demonstrated while in the atomic state, and in like manner the waters of the ocean may be full of all rocky minerals besides the alkalines and salts—these latter are within it in a dissolved condition, but not in the creative sense in the atomic state—and yet are beyond the reach of science to be discovered.

The atomic state of matter, as applied to creation—not the gross atoms we are accustomed to think of—is in itself a wonder-study. This in an equal degree applies to the growth of a man, a vegetable, or a world, We see the majestic oak, and know that its whole bulk is made up of creative atoms, none of which the greatest men with their refined instruments can detect, simply because there is nothing gross in the atoms themselves. They are from creative hands, so to speak, purely spiritual. The man eats a piece of bread as necessary for the support of life, but there is nothing in the bread that we can see and detect that gives nourishment—anything which is visible in it, even to the microscope, instead of nourishing would destroy. The bread in its grossness is swallowed however, but kind nature steps in and relieves the system of the whole of the eaten bread, but the unseen elixir is retained and the man is nourished. The world grows bigger on the same principle. The millions of aerolites which constantly descend upon it are nothing but collections of matter condensed or brought together by revolving motion from the pure invisible fluid state, in which condition, through the absence of pressure, they remain, and when brought into contact with the air, by their velocity of motion are instantly spread out into their original invisible state, and thus settle down unseen and unknown. Such reasoning may be put down as fanciful, but if we turn to the formations that continue to go on in different parts of the world, it will be almost, if not altogether, reduced to fact. In the tropical oceans it may be all but affirmed that continents are rising from coral formation, which is continually increasing on a gigantic scale, and gradually adding to the size of our globe. These corals are nothing but stone in a certain condition, all grown, nourished, and drawn from the waters alone; and if we take into consideration the bulk of these formations, which have been thus generated from the water during the past, including marbles, chalks, limestone, and shell deposits, whether they may be under or above the sea, within or without the strata, taken in the aggregate they are greater than the entire bulk of the ocean. Thus the oceans must be constantly receiving fresh supplies of the stony atoms, which keep up its fertility in the formation of rock, or the production would as certainly cease as that cultivated land would without manure become barren. From what source, then, does the stony supply come from? for it must be continually added to the sea, or else shell formation would cease. The supply may or may not come from aerolites, for the question is hypothetically submitted, and therefore with reserve; but this we are certain of, that the materials of the shell formations, all drawn from the water, proceed from a constant supply received from without, and through which the oceans are being slowly filled up, or rather raised to a higher level,* and the world enlarged.

That all aerolites come from beyond, having had no previous connection with the earth, and that they are matter which descend, are truths now universally admitted. We thus far tread on safe ground in asserting that the earth is growing, and its growth must be according to the quantity of material it constantly receives. We think, therefore, it must be apparent to every reflective mind, that the quantity it receives must vastly exceed the stones which descend from the aerolites, in whatever manner the remainder may be disposed of, whether in their primal atomic, and consequently undiscoverable condition or otherwise. What may be the proportion of matter which we cannot see, to the innumerable meteorites which come down as palpable entities it is impossible to say, or what becomes of the unseen portion, for want of more advanced knowledge upon the subject, no finality can be safely arrived at. But whatever may be the proportion of the unseen, supposing it to be ten thousand times greater, all the millions of aerolites which increase the bulk of our earth in a year, compared to the whole, or even in a hundred years, in comparison is infinitesimal. Let us go further and add that, if in the days of Adam a girth measure to an inch—if the feat was possible—had been drawn round the earth, and the same to be repeated in our time, there would be found little or no increase. If anything, we would be inclined to think that a rather shorter line would go round it at present; for it is under the sea the world is growing, and our fresh-water deposits tell us that for the last six thousand years no new continents have risen. Thus, during that period, while new creation has elevated the sea, the wear and tear of time has worn down a something from the land, imparting to the entire ball a more perfect mould, round which a line of no greater length might surround it, while it is actually enlarged as a body by six thousand years of creative increase. Taking any view of the question, and supposing the total matter of aerolites to be in a million times greater proportion than the stones they discharge, it must have taken a great many million years for the earth to have risen from an atom to its present magnitude, on the reasonable basis that matter originated and collected from the atomic state into aerolites in the same abundance for the whole period as at present.

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* As the sea becomes filled up its waters get no less, but its level unquestionably is raised in the same degree higher. Had scientists, about three hundred years ago, noted to a hairbreadth high-water mark, we could now tell to a nicety how much the world during that space of time has grown. The difference of the sea level would likely be only measurable by inches, but the discovery would enable us to vaguely calculate the age of creation, on the reasonable supposition that matter has originated in quantity at an even rate from the beginning. We are not, however, without proof of the slow and constant elevation of the sea, if we examine deltaic formations. All such formations, as they now take place, are universally at least as high as high-water mark, but the ancient parts of the same deltas are, as far as we are aware, considerably below the same levels. They are where they were at first, but the sea is elevated since their formation that much higher. We see it exemplified in our Thames flats. The Po in Italy, in its tidal portion, runs for a long distance elevated above the deltaic flats on each side of it. The kingdom of Holland is a still more notable example of the gradual rise of the sea; the entire country is a delta, which when formed must have been on the highest level of the sea, but the latter is now elevated several feet higher. If the question was generally searched into, the same facts might be found to hold good in connection with mostly all deltaic formations. We are almost tempted to believe that the elevation gained by the sea above the ancient deltas is the measure of terrestrial growth from the deluge to the present.

Stratification proves the growth of the world far more strongly than any words which can be advanced on the momentous question; thus any one possessed of a smattering of geology, if he compares the underlying strata with the changes going on, must be convinced that each bed or stratum singly took up a long period in its formation, and all the strata were formed, according to their order, in geological epochs peculiar to each of them. Our real reason, however, for referring to the strata of the earth, is that they give infallible proof that it, as a body, continues to grow. Thus, so far as we have been enabled to penetrate into the crust of the earth—and the rule holds good over every part of its surface—stratum succeeds stratum, however deep we may descend, all lying, as to time, in the order of their formation. They cannot generally be otherwise, as no convulsions of nature could have ever reversed the position of one stratum by superimposing it upon another. If we sink down to the depth of say a thousand yards, we pass through the works, perhaps, of several geological epochs—the first one that on which the drift of the deluge rests, the latest formation; the next—if in the sinking there is no missing link—a step in time earlier, and so on in succession until we reach the lowest stratum at the depth we have mentioned, which of course is the oldest in the series. There it is just where it was deposited, perhaps more than a million years ago, while all the others have been superimposed, in their respective geological epochs, up to the surface.

Where could all the materials have come from that form the superincumbent three thousand feet? for when this lowest stratum—at that depth reached—was formed, it must then have been on the surface. It is still where it was at first; but time has accumulated matter above it till it is at last a thousand yards below. It is at that depth down not in one exceptional position, for the formations of the same date may be found at a like depth in any part of the world; so that superincumbent matter represents just the thickness the earth has swelled in magnitude since the time it was deposited then on the surface, but now buried by creative increase three thousand feet below. The rings of a tree tell its age accurately by years, and these strata or rings that make up the crust of the earth,* with the

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* We suppose that geologists labour under a serious error in concluding the

the same certainty inform us of its epochal years, from any depth to which we can sink up to the surface, each stratum in itself proving that the earth grew and increased that thickness during its formation. The stratum itself, if of sandstone formation, is partly formed from the decay of the primary rocks, which crop out in many positions over the land, but so far as its materials are borrowed from the land, they are only loose washed sand, and they would remain so for ever; but they are filled up with a pure stony gluten, or in plainer terms, the whole is petrified by material drawn from the water, the same as the shell formation. Thus, when the turn comes for any particular marine formation to be dry land, instead of loose sand it reappears in petrified mass as solid rock.* Taking these ideas as true, certain species of secondary rocks are made up, one-half of the grains of sand drawn by running water from the land, and the other half from new creation in the atomic state eternally held in invisible suspense in the waters. The supplies, as fast as they become exhausted, are kept up by new creation, seen and unseen, from the atom to the aerolite, and in rare instances up to the planetoid itself, constantly coming in from without, and in the manner described getting mixed with the ocean. Within the watery element it remains suspended in a proportion we cannot determine, invisible, undiscovered, and undiscoverable—for, we repeat, matter in the atomic state is beyond human science to detect—hence, the stony creation in the waves could only be looked for with the same result, as trying to see the volumes of water in the atomic state evaporated round us in a clear day.

The stone-producing quality of the ocean is wonderful. The

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earth throughout is mainly composed of granite, and that our secondary rocks are only the abrased particles which time has worn down from the primitive granite, and which only fill up the hollows on the earth's surface. If there is any truth in what we are advancing on the growth of the earth,—should the epochal rings not be obliterated by internal heat,—the strata form nearly its whole bulk from the date of its first atmosphere, and that the primary rocks are only the exception.

We imagine—the idea is given for what it is worth—under the supposition that the interior of the earth is in a liquid state, that great geological changes occur through the explosion of internal gases causing the outer crust to crack, out of which the liquid matter escapes, and hardens down into our granite ranges. If such changes have been so brought about, they would account for wide tracts of country being covered with the primitive rocks, through the melted materials becoming spread out by gravitation before they had time to congeal. We often hear geologists say there is no use in searching for coal where the formation is primitive, under the impression that the same granite rock continues unchanged to the heart of the earth. It might be, if they were to sink deep enough into some of these primitive rocks in low districts, it would be discovered that the granite only overlaps some of the coal-bearing strata which lie beneath.

* It may be objected to the general view of petrifaction here taken, that there are no signs of any of the sea-covered sands within our reach becoming petrified. The sands we are familiar with are under shallow water, in which, according to their depth, the creative fluid must be less, and therefore too scant to transform sands into rock. It is down below the bottom of the lowest depths that petrifaction is most perfectly developed.

washed sands of time are cemented together by its atoms in invisible suspense, and in turn is heaved up to us in solid rock—new continents of limestone are slowly rising, all drawn from the water, and the time will come when the lands we tread upon will form the bottom of the ocean. Then all our land deposits, our gravels, our brown sands,—in short, our drifts, will be permeated through and through and filled up and made solid by the new creative fluid. They will again protrude in the remote future above the ocean, presenting to the geologists of the time the latest orders of the conglomerate. Within it they will find that their race existed during its formation, for in breaking off the fragments they will be sure to hit sometimes on specimens of human art. In the heart of chalk-rocks ships with their lost argosies will be met with, and when they drop upon the treasures of art in a petrified city, the archæologists of that era will have a rich abundance of the antique, with which by their learned theories to enlighten the world.

Here we are led to suppose that, if the modern geologist was to bestow more of his attention upon the species of rocks which were at first land deposits, he might obtain a clearer conception of the state of the world at the time of their formation, than by his present mode of investigation. The rocks formed respectively by sea and land can for the most part, we suppose, be distinguished by their colour. Sea deposits are always bleached more or less white, but land deposits, except it may be in what were the beds of streams or lakes, never. When we therefore see hills of white sandstone, we may with little hesitation put them down as marine deposits, but if the stone, whether sand or conglomerate, is of a rusty red, or what we may look upon through atmospheric action as of a natural colour, it may be taken as having been originally dry land deposits, of course depressed under the ocean, and by its petrifying qualities transformed into rock. These dark coloured rocks of sandstone have generally a mixture of pebbles in their composition, while in the marine sandstone, the fine and coarse are seldom or never intermixed; another difference is that the stratification in the brown sandsone is always imperfect. As to the conglomerates, it is likely the most of them have been dry land formations, in which case the remains of land animals might in them be as frequently met with, as marine remains within the sea-worn materials of oceanic formation.

In what proportion aerolites, as to given time, in the earlier periods of creation added to the earth, is of course what we cannot determine. We at least know this, that at present, and as far back as human knowledge extends, they from atoms up to planetoids came, they never cease coming and that in millions, and as they thus slowly add to the earth, they by so much bury the strata already formed deeper out of sight. And if the operations continue to go on long enough, as in the past, the time will come when the ground we tread upon, in its turn, will be thousands of feet below the surface, all the deposits turned into solid rocks, with our peat bogs petrified into coal-measures, and the existing underlying strata be that measurement deeper down than at present. The never-ending shower of matter comes into us drop by drop, swelling our globe inch by inch imperceptibly into greater magnitude, and it will continue so until the purposes of the Creator are fulfilled in calling matter into existence. The operations themselves prove that matter had a beginning. What begins must end, and however unscientific the expression, we venture to add that the worlds will surely pass away. It may be by some unknown natural process, slow as their creation, for Almighty Wisdom is unsearchable, and His ways past finding out.

CHAPTER XXIV.

STAR FORMATION, OR CREATION IN THE ATOMIC PERIOD.

HAVING thus far, according to our weak ability, proved that creation is a work still going on, and that the world like the growing tree imperceptibly gets bigger, we may next turn in imagination to the beginning, or rather immediately previous to it, when there was no matter. To mortal eye darkness prevailed over the face of the deep. There then existed no sun, no stars, no moons, no worlds—all was darkness, the black darkness of the mine. At last it was the will of the Mighty Sovereign of the universe that an infinity of worlds should come into being, so as in time to become the nurseries of immortal beings, and matter by some unknown natural process began to generate in an atomic state.

The atomic state we have no right to take for granted in judging of the subject *per se,* without any relation to others; but in broadly viewing creation as a whole, we find that all formations are collected primarily from atoms. The mountains of coral and chalk, together with the tiny particles of mist or drops of rain, are all drawn direct from matter in the atomic state; and the same applies to every collection of matter that has life, from the stately tree to the blade of grass, or from the huge elephant down to the meanest insect—all owe their existence to the countless millions of atoms of matter which they are constantly absorbing suitable to their growth. The matter, therefore, which makes up the worlds, whatever modifications it may undergo in its gross condition, is primarily collected from the atomic state, and while in the creative sense atomic it can neither be felt nor seen, yet it exists. At the fiat of the Almighty, before any world had a being, or a collection of matter however small had taken place, simply by some unknown natural law it began to generate, how or why it is not given us to know; and that space was previously barren in the production of matter, we of course cannot answer, nor does it in reasoning out the subject concern us. Enough for our purpose that creation is still going on, and the worlds in an equal degree growing larger. We are, from these operations, enabled to trace them step by step to the time of their first beginning, however long that may be, as clearly as if we had been a living witness of the whole progressive operations from when they began as atoms until they attained their present enormous magnitudes.

When matter in the atomic state first began, it no doubt had attraction, and, according to the popular idea, in this state atom would attract atom magnet-like, and thus the worlds would at once begin the moment the first atoms originated. A greater error could not be conceived than that matter in this primal condition could be thus acted upon. The sun, with all his power, cannot draw nearer to himself the smallest planetoid; much less is it possible that the primal atoms of creation, all of an equal size, or properly speaking without size, could have the smallest magnetic influence upon each other; and if so, the worlds could not have begun from such agency. We cannot afford space to technically enter upon the subject why attraction under such conditions is powerless for the purpose, and therefore at present will set out with the broad assertion, that, while it in the primal formation of the worlds was an indispensable force, yet, it was then and always will be subordinate to motion, the active agent which in the first place collects matter out of its atomic state, and without which suns would, but no other worlds could have ever existed. The question therefore remains, How did motion originate, the one thing indispensable to collect together into bodies the new created matter? If once rotatory motion in only a single particle was set a-going, the work would be thus far done; for the motion of one body, even if only a grain of dust on an axis, would at once impart motion to the atomic matter around, and like the wave ripple, it would widely spread, and the formation of a sun be begun. The question, however, again recurs, What set the first particles in axial motion which were destined to swell out into suns? for it is from this motion that all other motions were to follow, and in the future be the active agency in the formation of secondary bodies. There was no existing active force that could originate the motion; for thus far we must look upon matter as simply generating by some natural law far above our conception, perhaps in about equal quantity over all space, through which the Almighty Author decreed that worlds should exist, and being free from all impulse as yet, continued to remain inert in its atomic condition. This early state of creation likely continued unchanged for several million years, space becoming more thickly impregnated with matter during all that time, but still invisible as the stony atoms in the ocean, which are slowly building up chalk and coral continents on its bottom. If such a time elapsed before motion originated, we may here ask, What, in such a condition of matter, must have been the general appearance of the heavens, without a world or even a single particle spread over an immensity of space, in such vast quantity in the inert atomic state? We suppose, like the evaporated water in the air and the rocks of stone in atomic suspense in the body of the ocean, it in itself was invisible. One of its qualities, however, was light, which in all conditions is in quantity proportionate to the matter it emanates from, quite irrespective of the state it may be in, whether collected into solid bodies or hanging as diluted immobile vapour over the expanse which it may take up. A subdued glow of light under such a condition must therefore have pervaded this spot of the universe—the space that is taken up by all the visible stars—and caused a reflection on the otherwise imperceptible matter, which likely appeared as an unbroken cloud of a dull luminous colour, in appearance similar to the white clouds of the Galaxy or Milky Way.

Here the thread of our reasoning must be broken, to pass some remarks on these mysterious nebulosities, all of which we submit as purely hypothetical. It would be ignorant presumption to speak positively on appearances so infinitely remote, without any items of direct proof in support of the ideas. The Milky Way is generally supposed to be a collection or collections of suns, so thickly placed together as to form what is termed a pavement of suns—not actually joining each other, but so numerous as to present to us at this distance an unbroken luminous front of stars of the tenth magnitude, not lying at the same distance from us, but from their vast number in the line of vision presenting the above unbroken luminous appearance. How they were enabled to rank them as stars of the tenth magnitude we are at a loss to know, for not a single star has ever been identified as one of the atoms of these clouds; and as regards suns being so numerous on the line of vision as to form an unbroken front, there is no doubt that in any other direction of the heavens, by going deep enough into infinitude, there are stars in sufficient numbers to present a pavement, yet in these other directions there is no visible background, as in the Galaxy. Again, no matter what the distance may be, if the uniform colour proceeded from a multiplicity of suns so thick as to be without a break, the nebulous expanse, instead of being a dull whitish colour—not unlike passing clouds of the palest light colour—would all be bright, throughout an unbroken starry whiteness. In the next place, if these clouds are not appearances produced by innumerable stars close together, what are they? The only safe reply can be given is, that they are matter in some condition or other, for all things which can be either seen, heard, or felt, must be matter; but judging from the nature of light, and the effects that greater lights have in putting out lesser lights, added to the above reasons, it is evident they cannot be collections of suns. It may be that they are vaporous matter still in its inert primal atomic state, hanging in suspense over regions of infinity vast beyond conception, wherein motion has not yet originated, thickly impregnated or rather diluted with matter when once set in motion to become reduced into myriads of suns and worlds.

Whatever may be the condition of the Milky Way, the colour of its clouds is just what we would expect our own starry portion of the universe to have been, if atoms constantly increased equally throughout during the first few million years of the creative period, invested with a necessarily subdued light of much the same luminosity common to the whole. How long a time had elapsed from the origin of the first atoms, until they had increased in density to show as a white cloud faintly visible, or from then to the time they attained the luminosity of the Galaxy, are questions which of course are impossible to answer. Again, matter in its diffused state, if it reached in our portion of space such a density before motion originated, is a question on which we must be equally ignorant. But, it is important to repeat, the proportion created in our space up to this time without motion could never have been, at least, collected into secondary bodies, and this again raises the old question, How was motion set agoing?

The drop of rain condenses from the invisible aqueous atoms, it is supposed, only when the air becomes overcharged, and it so happened that at some solitary point within what was then our Milky Way, where atomic matter was thickest, some of this matter as in the drop of rain condensed into a particle, the operation itself imparting to it axial motion. The condensation of the particle was all—in such a condition of matter—that was wanted for the formation of a sun, and its axial motion for the production in after time of subject worlds under it. By the time this particle was formed there was created sufficient atomic matter over the face of the future system, when all would be collected, to give magnitude to the new sun large enough to govern it. However, the instant the work was begun, what was destined soon to become a mighty sun was as yet but a tiny particle—it may have been so small as to be invisible, but still it was an attractive centre; it was the only object that was gross in this portion of space, and therefore it must have been a centre into which the fluid matter close to it fell. Its attractive sphere extended perhaps but a few inches, from over this narrow area the invisible matter dropped in, and thus becoming enlarged its attraction spread out wider, so that creation gravitated in from still greater expanse. Thus, the little body that from condensation began as a mote, rapidly increased into greater magnitude, and as it got larger its attraction spreads out still wider and wider, till at last it grasped a comparatively wide sphere of the ancient creative fluid, all rapidly falling in to its enlargement.

This first-born sun in our firmament rises as it were by enchantment into magnitude, and the question follows, Is its spreading attraction to rapidly extend out interminably? If so, the great expanse would have been left bare of suns, as this one would have usurped the whole, and all would have centred into it, except the moiety which material operations held back for planetary formation. But Nature, which in one sense is another name for the Creator, does all things well, and set limits to its first-formed system beyond which it could extend no wider than the attraction of the sun in its centre would reach in its weakest possible state. When it first became a tiny particle, its attraction with infinitesimal force spread—there was no opposing attraction at the time—considerably, and as it increased in size, its influence extended wider; but at each successive step the new fields of atoms in the surrounding space, into which its force could penetrate, became in proportion less, till at last, when a certain width of diameter was taken in,—not such a diameter as we are accustomed to regard a solar system at present,—the attraction of the new-formed central body died out at the borders. Beyond this, it as yet had no power to lay hold of the ancient nebulous matter in suspense. Whatever may have been that expanse, within it was contained, in its primal stage of development, the first existing system of our star space.

To repeat briefly, in other words, the formation of the first sun and system : we are to suppose that over the space of our starry system, there was at the first matter diffused in an invisible state, which continually became thicker and more dense through creative increase during a course, it may be, of millions of years; but the expanse at last getting overcharged, from this cause at a certain point the atoms condensed into a particle, and, as above described, the formation having once taken place, it soon increased to a sun. This first step of magnitude which this sun attained, was according to nearly the total of the fluid matter its attraction could lay hold of when collected together, and just so large as it then was, in the same degree was its system wider, limited only to the extent the force of its attraction in its weakest possible state could reach.* Beyond this at all points it as yet had no power to draw into itself any more created luminosity. Yet the limits in this first step of its formation were temporary, and destined to be gradually and slowly very much expanded in the succeeding ages; but not to such an undue extent as to disturb the harmony of nature. We are to look upon this first-born sun amongst our visible stars as having been formed somewhere within the white cloud, at a point where the vapour was thickest, and that in this the initial step of its formation, with the total expanse of its system, it bore about the same relation to the whole as a grain to a hill of sand. The stony mist was only cleared away as far as its attraction spread out. All the matter hitherto within this expanse was therefore incorporated in the new body, now invested with a brilliancy according to its acquired magnitude, and perfectly spherical, for atoms and aerolites† descended upon it in equal proportion from every point. Still, the heavens were of a hazy dulness round all points from the limits of the new system outwards; for in the greater distance the white luminosity still extended unbroken for billions of miles, over the expanse which is now taken up with our starry hosts. How long this state of inertia in the outer regions from the new system continued, cannot be told, but until the mist was totally cleared away round the expanse by the formation of the other suns—a work which time was sure to accomplish—it is possible another hundred million years had to pass away for the purpose, before there was a uniformly blue sky. During most of that time, this first sun of our firmament was getting greater in magnitude, not only by natural increase, but through the gradual expansion of its system, thus constantly laying hold of new fields of creation which gravitated to its enlargement. It was now at the end of the first step of its formation within a clear spherical space, over which matter generated as at present, but not to continue in a state of immobility as before. The infant sun, as a great centre of attraction, was in the middle space to at once draw in new creation the instant it existed, in the same way as our sun is at present acting on atomic matter within his system, so that it was constantly getting bigger and extending its stronger attraction still wider into the circumambient mist. This latter descending in addition—perhaps in a million times greater quantity than the new-created atoms of the cleared space—was that much in excess of the natural increase to the new sun, so that by constantly increasing magnitude, the area of its attraction spread out step by step into wider limits before all the other centres sprung up around, till at last, there is no doubt, it advanced to the status of one of the monster suns of our star space.

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* There is a general belief that attraction spreads out without limits, and that it reaches us even from the stars. It is well known that attraction from a body is a decreasing force, and the least reflection on the subject should teach us that as it decreases by distance, it must at last dwindle down to nothing, no matter from what source it may spring.

† A proportion of the atoms, by their revolving motions, accumulated into aerolites in their descent to the new sun.

Some one sun in our Galaxy must have taken the precedence of all the others, and we have submitted our humble description of its formation, whichever one of the bright stars it may be. At various points of the cloud, space was becoming overcharged with the created fluid in like manner, and the nuclei of other suns began—one perhaps at some distance from the first sun, as far as the nearest stars, another at the same or greater distance in a contrary direction, and so on over the great expanse, something like the distances on an average intervening betwixt them all in their several positions at present, each one becoming formed into a sun and system after the manner of the first. One and all of these being thus by nature placed far apart and solitary by themselves, they had the start by, perhaps, millions of years of the myriads of smaller suns and sunlets that in the intervening spaces were to follow, and had prior facilities to increase as a class enormously into those great suns, which were in after time to adorn the firmament. When they were in their respective positions first formed, they and the expanses of space they ruled over were just as wide and no wider than their attractive forces could severally extend, and in average expanse no more extended than the systems of the smallest class of suns; but being in solitary spots, lost in the immensity of the white cloud, by natural increase their attraction severally spread wider and wider into the mist of ages, without meeting with opposing forces for perhaps millions of years, till in the end they ruled over spaces, as systems, of abnormal expanse. This accounts for the monster suns which are so conspicuous in the heavens.

With the formation of these grandest luminaries of the heavens, the idea might be had that the ancient Galaxy being cleared from their systems, by this time the great cloud would be breaking up and streaks of blue sky showing through. This as yet could not be, for these two or three thousand suns with their spheres of attraction were lost in the mighty space; spots by comparison so small that if silvered over with sheets of borrowed light, to the distant vision the one from the other would be all but imperceptible. In reality, the cloud for so far was an unbroken whole; but all its parts were still becoming more thickly impregnated with matter, so that other centres of attraction were in the course of time gradually springing up at different points, which, in tens of thousands became suns another step lower in degree, and bodies of a still lower status followed—the suns of the telescope. By this time the cloud was beginning to break, and long after, when the last fleecy morsels had disappeared to the naked eye, there was a clear sky, spangled over diamond-like in glittering splendour everywhere to view, but much smaller than they now are. As yet, each one was solitary by itself, for their subject-worlds, by the action of their axial motions, had yet in the coming time to be formed.

The work of gathering in atomic creation up to our time is so far perfected, that unassisted vision looking broadly on the face of heaven can only discern a clear sky—excepting the Milky Way, which we suppose lies entirely outside our starry space. The question arises, judging from these appearances, Is the work finished—are there no remnants of the luminous stone vapour still left uncollected here and there in the intervals betwixt the stars? Our best telescopes inform us that there are still nebulous spots of a milky colour, solitary by themselves, and if these spots are in reality expanses of matter still in its primal state, so placed that the attractive forces of no bodies can reach them, suns even yet are continuing to be formed; thus proving that these primary bodies have been coming into existence gradually in our part of the Galaxy, may be, for more than a thousand million years, and yet morsels of the ancient mist still continue. They only appear to view by the power of the telescope, and are of the same colour as the Milky Way. That they are collections of stars would be absurd to conclude, for they lie sufficiently near for the telescope to have power over them; yet that they are matter in some state or other no one can doubt. Their outlines in many instances are irregular, but in some cases circular, and when they are so the appearances may be more apparent than real. The reason that any of these spots are left, if they are actually the last remnants of our Milky Way, is, that the suns or bodies which lie nearest them have no attractive spheres which stretch wide enough to lay hold of their atoms. They are expansions of space perhaps wide enough for small systems, impregnated with matter still in the primal atomic state, which even up to this time have not yet become overcharged so as to condense into centres, and thus be cleared away into the bodies of new suns. However—taking these ideas to be true—the time will come when these last fleecy remnants of creation in what may be termed its first stage will disappear, and not a flake of the once universal luminous halo be left behind within the visible precincts of space.

Our hypothesis of the Milky Way—the description given of the formation of our star system can be called by no other name—raises curious reflections as to what may be the state of infinitude as a whole. Is there a continuation of suns and worlds without end? We may concede it is perfectly reasonable to suppose that to any point of the celestial sphere, if we were removed to the most distant visible star, there would in the space beyond be revealed to view hosts of stars as numerous as those we had left behind; but this—if it were possible to make such a grand experiment—would only prove that material creation in this spot of space is wider than human eye can penetrate, and not that it is without limits. On the other hand, by closely studying creative operations, we obtain rational proof that a vast proportion of immensity may be void of matter, and therefore to mortal eye in total darkness; while, as a contrast, our position is within a galaxy of glittering suns, down to millions of minor suns and sunlets, ending in myriads of subject-worlds, taken altogether as exhibiting on the grandest scale the glories of the Creator in the material spots of infinity. We might again imagine another tract perhaps adjoining our starry expanse over which suns and systems are vastly older, and the space they occupy has long become barren in the generation of matter. Thus the matter composing these suns and worlds, is continuing by as slow a process as they were built up—by some unknown natural law—to vanish away, and at last to leave this ancient seat of material creation a dark empty abyss as at first. Finally, we have another contrast in the Milky Way. It very likely contains within its limits regions of space so immense as to be above the imagination to conceive, throughout—judging from appearances—not a solitary world, but over which creation has been impregnating space for millions of years with its fluid material, hanging inert in the atomic state, which will, when ripe for the purpose, collect itself together into hosts of suns and systems over the mighty expanse. Such reflections may be put down as intellectual hallucinations, and we are far from dogmatically submitting them as truths; but some of them at least will stand the ordeal of investigation. For instance, nothing can be clearer than that creation is now going on, and by it the worlds are growing bigger; and the operations themselves prove that by reasoning far enough back we reach a time when there were no worlds, no suns, or matter in any condition over the space of our star system:* it was an empty void, what this once was. It is not irrational to conclude that tracts of space over infinity thickly dotted with creation may be only exceptions, and all the rest, as regards materiality, dark and void, nothing to mortal eye visible, but to immortal vision regions of light through which angels tread. Again, the conclusion is not irrational that all things which begin must end. Surely not; for it is one of the soundest axioms in philosophy, and is adopted by every school of thinkers. The operations, therefore, going on prove the beginning of these suns and worlds as clearly as if we had lived and been eyewitnesses throughout the whole period, and so sure as they have begun from nothing, materially speaking, they will end in nothing, and the darkness mentioned in Genesis will once more replace the light of matter that is now universal over visible space.

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* The term "star system" is not here used in the sense usually understood, but as simply comprising all that portion of space, to whatever distance it

Reasoning upon the Milky Way *per se*,—if our hypothesis be true,—it is composed of regions of space immensely expanded, and its nearest portion more remote than the most distant visible star, lying in the same direction. In looking upon its clouds, we can clearly discern that they are all luminous, but in very different degree. Were it not for their luminosity they would be undiscernible, and we suppose the glow is of a deeper white in positions where the quantity of creative fluid is greatest. In some portions the luminosity is barely perceptible, and over such regions it may be that creation is young; in other portions we see the clouds of a livelier brightness, which proves a greater diffusion of light, and therefore an impregnation of atomic matter in the same degree greater. Finally, in carefully scanning these regions of luminosity, we can mark out over the panorama the brightest patches; and as matter in all conditions must emit light according to its quantity, we may conclude that these patches are the most thickly impregnated with atomic creation, and thus ripening up nearest that stage when the whole will eventually be dissolved into systems and suns. Indeed, within some of these most luminous spots, the great suns with their systems may—for what we can tell—be already formed, at solitary spots here and there, far apart from each other. The cloud they are within is still unbroken, and as these gradual operations would take millions of years to clear away the luminosity, the disappearance of any one of them being so slow and gradual could never be marked down and witnessed. Those which are disappearing or have disappeared, could have left no observable marks of the changes behind them, for suns when formed at such a distance are far beyond the reach of terrestrial view. Even if it were possible for some one patch of the cloud to suddenly collect totally into suns, without any of its fleecy remnants being left behind, its disappearance from here could not be observed, as there would be no opening in the back-

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may extend, over which suns and worlds exist in about the same proportion as those within view. The star clusters which the telescope reveals, we take to be in nearer proximity than any of the bright stars.

ground. The space beyond would still remain closed up with regions of remoter luminosity.

Viewing these regions as a whole, they might be looked upon as a long stretch into the depth of infinity over which the Eternal is advancing material nature, most likely through space right and left void of creation. Through this abyss of darkness, without a world in the distance, within the Milky Way matter in the nebulous state is more or less developed according to the periods of time it first began to generate in the several positions which cover its immensity. Tracts where the nebulosities are thin and barely visible, may be looked upon as parts of space over which creation has not long begun, and where the colour is deeper the development by the lapse of time is in the same degree greater. Going still higher, we may suppose that the great suns with their systems are being born within the brightest spots, other clouds breaking up in a still more matured state, and in the long past systems of stars out of other portions of the clouds, which last of course have disappeared from view. Again, some of these sun systems, for what we know, may be perfected in the heart of these nebulous regions, in which case they can have no blue sky, but round at all points of the sphere a dull milky haze. We are in our starry space more fortunate, except in the one direction, and this shows that the part of the cloud out of which the suns within view became moulded was a nebulosity at an outward point of the Milky Way. We have the additional evidence, that it cannot be anything like an eternity of time since it dissolved into our suns, as there are some of its fleecy morsels still left even within that comparatively near space over which the telescope can magnify. It may also be, that there are remnants of the same kind in the other stellar intervals, but compared to the vast intervening space they are but little, for not one of them, we suppose, is of sufficient expanse to be visible.

So much for our hypothetical ideas of the Galaxy, views of the subject which of course cannot be proved either by direct or analogical evidence, and thus they may reasonably be put down as the delusions of a diseased intellect. We are, however, about to describe the particulars of the formation of our own sun and planets. The principle of their formation will wholly rest on matter being abundantly diffused over the expanse as above described; and whether our theorising be true or false, if matter had not been in such a pre-existing state, no suns or worlds of sufficient magnitude, to fulfil creative purposes, could have ever existed. We repeat, in the briefest terms, that long since in the dark abyss the first atoms generated, and in time developed into a constantly thicker state by creation at perhaps a uniform rate, continually adding to that previously generated through a prolonged period, and as light is a property equally with attraction common to all matter, when in such a diffused atomic state its halo in a subdued condition must have overspread the whole. Whatever the Milky Way may be, we can think of no other appearance our starry space could have shown—a fact, so far as regards colour, confirmed by the nebulæ of the telescope. At all events, it was out of such a primal condition of created matter that our sun had to begin, or we would now have no such glorious luminary to govern, or worlds to be governed. And, explaining the operations which attended their formation, our reasoning will mainly rest on the double basis, that creation is still going on, and that matter as it continues to be created is in its earliest state purely atomic, and during the first epoch of creation, when no attraction existed that could affect it, in this state it continued, whatever the period of time may have been, until it increased in quantity sufficient to bring into view the suns and worlds which are visible.

As to the continuation of creation, it is a fact capable of being universally established as an unassailable truth. What could be more conclusive than the hundreds of millions of aerolites, yearly descending upon the earth, of unknown magnitude, and, most likely, an equal quantity in a much lower scale all invisible down to atoms, silently enlarging our globe? Its constant growth is also demonstrated to a certainty by its crust formation. The stratum upon stratum, down as deep as man can dig, show in the first place the epochal rings of its growth, and the cement which binds the sands of the sea into rocks, the atoms from which the flints originate, and the calcareous formations which are raising continents of coral, limestone, and chalk on the bottoms of the oceans—all, be it remembered, drawn from the water—as an array of facts taken together prove with mathematical certainty that He who made the worlds is still making them and adding to their magnitude! Again, the whole range of science proves that matter which is constantly increasing, is, in its primal state, purely atomic. Every production of Nature is atomic. God creates the atoms as a primal entity out of which He fashions all things. It is atomic matter which permeates our bodies, and gives us life. The majestic oak and the grass of the field spring from atoms; and all natural productions, with or without life, in the heavens or the earth, the sea or land, take their organisations from the invisible entity atoms; and most assuredly the sun, moon, planets, and stars all in common had the same origin.

When speaking of atoms, in the creative sense, we must cast away every idea of what is gross. We often hear philosophers reasoning that it is impossible to descend to the original atom, for it admits of being divided, and the divided parts are still divisible. It is the particle they reason upon, and not the atom. There is no word in our vocabulary which can scientifically express the meaning, in a creative sense, of the word atom. As a something to be seen or felt, it is absolutely nothing, and therefore indivisible; and yet, abstractly considered, it is a material impalpable something, a name which signifies matter in an ethereal state, originating from creative will; it is, so to speak, of a spiritual purity, invisible to mortal eye. There is nothing more beautifully represents matter in its first state than the water evaporated into the air. It envelops us in vast abundance, yet it is unseen, unfelt, sensibly unknown, and utterly beyond the power of science to detect or discover. In being drawn up, nature restores it to what it was when first it came from the Creator's hands. But, letting that pass, there are still two divine essences which matter possesses to the highest perfection, even in its primal and, so to speak, spiritualistic condition, light and attraction; and when the fulness of its time comes in its luminous state, attraction collects it into grossness, previous to which, on account of its natural light, it was of a dull solar glow. If it was possible we could be in the midst of such a scene, the same as existed previous to the formation of suns, we would be simply in suspense, in a region apparently empty, with a subdued glow of light around us, and the distant view—without a blue sky—limited by the reflexion of light on the invisible matter in a state of inertia. It was in the heart of such a scene as this that our sun budded into existence as an insignificant particle. We cannot, however, enter upon this part of our subject until we meet the objection, Why did not matter begin to coalesce, and meet at an earlier period by the force of attraction?

New created matter, so long as it retains its primal condition—such as the volumes of water evaporated in the air—has, we repeat, within itself the properties of light and attraction in perfection; but in that state, while it is liable to be itself attracted, it has no power to attract. When any matter does attract, the attraction, to impose gravitation, comes from a body acting upon another—except in juxtaposition—vastly smaller than itself. But the primal atoms have no body or substance in any possible sense, and may be described as invisible entity, impregnating space equally. In this primal created state it continued quiescent, one portion had no power over another, while natural operations by new matter continually increased the density, till at some point an overcharge is at last reached, then the atomic matter, like the particle of mist or the drop of rain, is condensed into a solid, which by the operation is set turning on an axis, and thus a sun is begun, and that motion originated which will in time form a number of subject worlds under it. Yet, from the well-known prejudices upon the subject, the foregoing reasons as to attraction remaining inoperative until space became impregnated to the required density by the creative fluid, may be demurred to. It will still be argued, that from the instant—in the utmost state of attenuation—matter first began to exist, nothing could prevent atom attracting atom, and thus collecting into drops or particles in every direction. Under such operations, attractive centres would have everywhere sprung up, as difficult to number as drops of hail, and all creation would have centred into little globules of matter as great in number as they were small, and as independent of each other as the actual suns which exist. Such a condition of creation would have rendered the works of God a mockery; for on these little bodies—not one of them, if subject to the earth's attraction, too heavy for a man to carry—no living things could have existed. In the next place, if solar centres had sprung up in the luminosity, when the fluid matter had generated not up to such a quantity as to meet the purposes of Creative Wisdom in providing abodes fit for life, by being thus prematurely collected, centres would have sprung up as numerous as the total matter up to that time was small. This would have resulted in an endless development of little sunlets, with planets subsequently formed under them in the same degree smaller—in short, insignificant asteroidal formations, on which no sufficient heat for the support of life could have been raised by the thin coverings of atmospheres they would possibly have drawn from the comets they might chance to pass through. In one word, if suns had been formed in too early a stage of creation they would have been too numerous, and the planets to be formed afterwards—through their axial motions—too small; and on the other hand, if matter had generated in too great quantity before their formation, they and their systems and subject bodies would have been too large. The course of nature, however, always leads to the most perfect results; so the cloud had to become dense to a certain degree by a gradual thickening of the unseen matter, until at the right time, at particular points far apart, suns of course burst forth, not simultaneously but at various periods, according as matter became ripe for the change in the several positions.

All centres which thus sprang up through the overcharge of matter, in its primal fluid condition, of necessity became suns—we cannot conceive it to be possible that any governed bodies could have thus originated—and they drew into themselves nearly all matter created up to that time within the areas of their respective systems. Our sun, in like manner, originated and brought in to himself, except a very small moiety, all creation then within his system, the limits of which, in the first step of his formation, being confined to the utmost extent his attraction could spread, and that depended on the comparative magnitude he had then attained as a body. And it is wonderful how far from any one body attraction will act. The present attraction of the sun, for instance, stretches out to the remotest limits of his dominions, and—while it is without influence in the space beyond—actually as much farther out as he has increased in magnitude since the system was extended to its existing boundaries. Viewed in this light, we may form a vague idea what may have been the then expanse of the system at the end of the initial step of his formation, supposing his total bulk—when all the matter his attraction could lay hold of was drawn in—to be about as large as the smallest of the minor planets. Whatever the expanse, it may not have been wider than the earth's orbit, but whether less or more, it was no wider than the existing systems of the lowest type of minor suns. These last were formed under precisely the same circumstances as greater suns, and at their first formation must have been about the same size; but they being formed out of the last fleecy remnants of the white clouds, their borders were bound in from the first by the precincts of the larger and earlier formed suns. They could thus extend their systems no wider, while the suns earlier formed were enabled to expand their spheres of rule so long as the atomic regions on their borders remained unappropriated by the formation of the inferior suns in the next lower step. For it may be once more repeated, that new-formed suns must spread out their dominions wider and wider, so long as the ancient fluid remains unappropriated by exterior forces on their borders, but once their attractive forces meet these dividing landmarks, the boundaries of their systems are fixed for ever. No matter how much nature may enlarge them in the future, their power can never extend wider. It is, therefore, a natural result that mighty suns should have sprung into being in spots for the most part far from each other, and that such bodies would graduate downwards to a minimum, maybe smaller in size than the earth—a class of sunlets perhaps more numerous than all other solar bodies taken together. As soon as they were formed their permanent borders were defined, for there was left little or no virgin space surrounding them to conquer, while the class of suns in the next higher step preyed on the border mists a short time only, hence their greater magnitude. We thus ascend step by step to higher grades, up to the stars themselves—the first-born suns in the white cloud—which in their several positions, lost in the distance from each other, may have taken millions of years in the gradual subjugation of wider space around them, before the mists were entirely cleared away from their respective borders.

CHAPTER XXV.

FORMATION OF THE SUN.

OUR sun undoubtedly ranks with the stars or suns of the first magnitude, and therefore must have come into existence as one of the earliest suns that were formed in the cloud. It could not have been on the outside, but somewhere in the heart of the great luminosity he first took existence, for other great suns surrounded him at all points of the sphere. To describe his first beginning will be going over trodden ground, yet we must do so, for otherwise our weak description of his formation, and that of his system, would come out still more imperfectly. As soon as the fluid matter condensed into a particle,—just where the centre of the sun now is,—it at once became an attractive centre, with a sphere of attraction as wide as its weak attraction could extend, and from within this very narrow area atomic creation began to gravitate in. It became bigger, and its attractive sphere spread in the same degree wider, perhaps a hundred times farther into the surrounding mists than the space already cleared, all of which in like manner instantly began gravitating into the common centre, enlarging it in a vastly greater degree, and enabling it to stretch out its attraction into distance still more remote. The wider the circuit grew, matter in increased abundance was drawn in to the enlargement of our infant sun.

This rapid process in the first step of our sun's formation could only go on to a limited expanse, just so long as its attraction could reach the fluid creation in the circumambient space. When the work over this expanse was accomplished, the new system—now cleared of the atomic creation of ages—we take to have been only equal to that of the very lowest of the minor suns, but what its true diameter at this the initial and most important step of its formation then was, it is of course not given us to know. These particulars entirely depended on the magnitude of the newly-formed body itself, when the whole of the matter was drawn in. The larger it was, its attraction spread so much wider, within which there was now a clear sky; as the ancient ethereal matter, the accumulation of ages, had by this time all gravitated into it as the common centre. While it is impossible to tell, in this the first step of its formation, what the size of that centre, or rather our new sun was, it is not unreasonable to suppose that it may have been in magnitude as large as the smallest of the minor planets at present, with a space for its system of a spherical outline cleared of the mist, perhaps not wider than the orbit of the earth. Whatever may have been its first expanse, it only extended as far out as its attraction could reach, and as attraction like light spreads out wonderfully remote from a body, even supposing it was no bigger than we have named, this force and consequently its system may have extended considerably wider. Whatever may have been the expanse, it was the initiatory step of our sun to power. These would have been the confined limits of his dominion for ever, like that of the smallest minor suns, if atomic creation round the borders had been appropriated previously by the formation of the nearest suns. The sun, however, being one of the first which originated within our Galaxy, once his materials had been collected from an equal distance out of a spherical space—the then system—he had still around him in all directions the luminous vapour lying just clear of the bounds of his attractive sphere, and so long as this lasted, his dominion continued to spread wider in the coming time, till at last it included an extent of space, measured spherically, hundreds, we might say thousands, of times greater than the original narrow limits referred to. According to the additional space subdued, by the constant spread of his attraction, he became in exactly the same degree a larger body. At the end of his initiatory step of formation, he may not have been larger than Mercury, but by the time his attraction grasped the final and fixed limits of his power his magnitude had no doubt become many thousand times greater.

If creation had stood still after our sun and system was formed in its first stage and narrow limits, they would have remained so for ever without the space becoming enlarged, or the body increased in magnitude; but we are justified in assuming, that the creative increase of matter went on then just the same as at present. Whatever matter, therefore, originated within the cleared-out space in the new system, had at once to descend on our little sun in the centre by gravitation, either as atoms or in aerolitic flakes. These increments continually coming in no doubt increased the bulk infinitesimally, considering the limited area out of which the sun by his attraction then drew upon; but however little, it was a constantly added something, which extended by increase of magnitude his attraction deeper into the mist, wherein, compared to the extent of space, matter was in quantity a million times greater, through it being the accumulated creative increase of the whole atomic period, all of which, the new created and the old fluid, constantly added to the central luminary and expanded out his system into wider area. In this manner the magnitude of the body and the expanding limits of the system went on increasing, while the mist of ages remained unbroken on the borders.

In the meantime other solar centres were from first to last, during a lapse it might be of millions of years, multiplying everywhere within the cloud, till at length it happened that some one of the minor suns attracted into itself the ancient inert matter in suspense on our borders. In whatever point that small solar body may be from our sun, it is the nearest, and forever hemmed in our system in that direction, that it could extend no wider; but in all other directions of the sphere, the mist of ages still remaining, the system to these exterior points as yet continued to spread wider. As long ages may, therefore, have intervened from the time the boundaries of the system were fixed in one direction, to when the operations of nature cleared away the border mists and marked the dividing lines in all other directions, it follows that the borders where the ancient matter continued longest, our sun's dominion in those directions in the same degree spreads wider. And as he is an immobile body, and must be in the exact point of space he first budded into existence, the expanse over which his attraction is predominant, or rather his system, instead of being to a certain extent spherical, may have very irregular outlines. As observed above, the nearest system to our sun has in its centre the first sun which was formed touching our borders, and where this occurred our system in that direction could expand no farther; but it may have been millions of years after, before the last remnants of the mist were cleared away from some other points round the sphere. For all that long period the sun's attraction in one or more directions gained new footing into remoter space. Thus, in whatever light the question is viewed, we are led to believe that the sun may be considerably out of the centre of the wide expanse over which his attraction predominates.

What is meant by the predominant attraction is all that space —whatever may be its irregular outlines—over which the attraction of the sun is stronger than that of any other body. This may be termed the dominion of the sun; but his system, properly so called, is of narrower expanse, and cannot extend wider than the nearest point governed by the nearest border sun. In more outlying regions subject to the sun, no matter how far out they may extend, it is impossible—while matter may, and no doubt does originate within them—that bodies can be over these immense expanses; as in going round their orbits, for want of room, they strike upon the outlying projections of the nearest systems, and, so far as formations can take place, they are carried hence under other suns. None of the planets in our system are so related, and thus they continue in faithful allegiance to our sun; but if Neptune is the outside planet, the system can be no wider, and its orbit being the outer ring, making reasonable allowance for free room, we might look for the dividing lines of the nearest system to be not more than four thousand million miles distant. This would make the full diameter of our sun's system eight thousand million miles, if he as the ruling body were in its centre, while the irregularities from the above causes may be such that the actual diameter might be as much as ten thousand million miles. In other words, the sun may only be four thousand million miles from the nearest dividing lines in one direction, and six thousand million miles in another, while the outlines in all directions—as far as broken borders would allow—would be nearly spherical, and the sun in the centre, if creation round all the borders had condensed into suns simultaneously. But this was impossible, and as immense periods of time most likely intervened betwixt the first and the last solar formations round our borders, the above supposed irregularities of our system—if science ever advances so far as to give us vague ideas of the outlines—might sometime or other be verified. Such knowledge is denied us, but whatever the general form of the sun's dominions may be, we know at least that they are fixed and unchangeable, and must continue so, no matter what magnitude he in the future may attain as a body; and the same relations have been without change since the last remnants of the mist gravitated into the bodies of the border suns. As to the relative period in the creative epoch the fixity of the outlines took place is of course another question beyond human research, but the consummation may not have been perfected at so very early a period if the nebulous spots the telescope brings to view are in reality the last remnants of what was once our Milky-Way.

CHAPTER XXVI.

ORIGIN OF MOTION.

HAVING described what we suppose was the first formation of the sun, and how the same operations in course of time defined the final and permanent outlines of the system, we are now better prepared to enter upon the question, What about the formation of planets, or, more properly speaking, the worlds? As bodies, in the creative scale they are much lower than suns, yet being designed as happy abodes for the living, they may be looked upon as of equal utility. Suns had to be first formed, or else their subject bodies could never have existed, and previous to their formation matter had to be developed in the fluid atomic state to raise,—when collected together,—primary bodies sufficiently large with systems extensive enough to afterwards in process of time rear up their worlds to magnitudes fit for habitation, or otherwise all the works of creation would have been in vain. Nature does all things well, and has fulfilled these conditions to perfection. Suns in their formation not only preceded worlds, but as a class of bodies they burst into perfection as it were suddenly, so far as they could in their first step of advance lay hold of atomic creation, whereas, their children, the worlds, have been gradually formed by constant and slow increase. Beginning first as atoms, they have risen to their present magnitudes by a continued growth without a check, and the same operations are still continuing to increase them as in the past. It is by the action of the suns they owe their existence, and without which no secondary bodies could have ever existed. Rotation is the action referred to, and if the suns had not been endowed with this motion all matter would have concentred into them only, and thus they would have for ever ruled their respective systems as total blanks, for all matter, as it continued to originate, would have gravitated into them in the pure atomic state, no part of it being left behind for the formation of secondary bodies. The wonderful effects which rotation produces, in the formation and government of the universe, must therefore claim our attention as to how it originated. Through its action the worlds were created, and it is the only motion which is free from material control, and once set agoing in a body, must go on at the same rate and in the same direction for ever.

We suppose it is next to impossible from the natural operations which began the worlds, that any body in the universe can be without axial motion, and that in each separate body it originated just at the instant it became an attractive centre.

While matter continued in the atomic state, there could have been no attractive centres, nor indeed attraction in any sense as we understand it, for the atom is scientifically nothing, and all being equally diffused no one part could act upon another—creation thus remained quiescent for ages. The time, however, came in various regions, that at some points far apart condensation set in. When that took place at any one point, a particle was formed which at once was a centre of attraction—it had to be that, however small, as it was free from the attraction of any other bodies acting upon it from any direction. The instant it attained grossness in the lowest degree—barely microscopic—the attractive force, although infinitesimal, turned towards its centre; this we suppose was the impulse which disturbed its equilibrium, and set it spinning on an axis at a speed according as to how it may have been internally acted upon. The impulse that first turned the equilibrium of any body in the past, must have been central, for we can think of no other force that could apply, except the attraction suddenly striking inwards the instant it turned in that direction. Had the particle been perfectly spherical, without any imaginary protuberance, it is difficult to see how axial motion could have been given it by the primal attractive shock, as it would have been a force meeting equally from all points. We suppose an unevenness in shape had to be on the outside form of the particle; this it must have had, as condensation could not have imposed upon it perfect roundness. The heavier surface weight thus set the sun, when a tiny speck of matter, turning; and the same motion which was then imparted to him, by the primal impulse of attraction at the first instant of his existence, he still retains—that is, one axial turning in every twenty-five days of our time. This was the last impulse, so far as we can judge, that he or indeed any other sun could ever have received, by which rotation would be imposed upon him, and when once set agoing it could never stop. It is the only celestial motion which requires no constantly impelling force, and that can neither change its direction nor increase or diminish. How wonderfully Almighty Wisdom and design are made manifest, by the simple turning of the first formed particle of matter! The worlds were formed and the mighty wonders outside the sun all originated from the turning of the primal mote of matter—the nucleus of a bright star!

Viewing the question otherwise, it may be contested whether or not our sun as well as other suns, during the course of their formation, after beginning as grains of dust, may have been entirely free from impulses that might have imparted to them their rotations after attaining greater magnitudes. In the first place, we may once more repeat, that bodies of matter which have attractive centres can have no weight; they are therefore without resistance, so that the least imaginable external impulse would move a body, be it particle or sun, or rather set it turning.

Everything that descends upon the sun is by the pulling force of his attraction ; the force, therefore, in all cases coming from himself, no impulses by the descent of matter could be given. It is thus impossible that rotation could have been imparted to him at any subsequent period, except at the exact instant it became an attractive centre not larger than the finest drop of rain; and the same rate of axial motion, given by that first internal attractive impulse, it still retains and will retain so long as he as a sun is permitted to exist. No doubt every second of time millions of aerolites descend upon him,—the largest class of bodies which can gravitate to the sun,—and they might be all looked upon as so many impulses given from without. If they were so, each one would undoubtedly send him spinning upon a new axis; but the aerolite is only affected—it is at the mercy of the sun, and hence, the thud * produced being all his own action, the forces neutralise each other. It is providential that such is the case, for if external impulses were imparted to bodies by very small ones falling upon them, through the drawing force of their own attraction, universal chaos would follow, as new created matter is for ever descending on all bodies, and will do so while creation continues to increase.

We suppose that rotation originated in governed bodies precisely the same as in suns, that is, at the instant they severally became attractive centres; but there is this marked difference, that suns began to rotate the instant condensation collected together the least imaginable thing that was gross ; whereas other bodies could only have been centres of attraction after attaining magnitude, having stronger attraction than that of the governing bodies reaching them. The little mote of matter which was the first nucleus of the sun was necessarily an attractive centre, for there was the attraction of no other body in opposition, but all planets having originated under the government of suns and within their precincts, they had to attain a magnitude with an attraction stronger than the same force reaching them from their sun or suns, wherever they might be. To go over the operations that raised them from atoms to this lowest but important step of independence, would only be a repetition of what has been heretofore advanced. Yet we may briefly observe, that all matter in falling to the sun is constantly liable to increase into greater collections, by one morsel uniting with another during its descent. Whatever may be its bulk while it continues to gravitate—if not above the level of such objects—its true name is an aerolite, or body which is gravitating to some other, reaching it with an attractive force stronger than that inherent in itself. As a collection of matter it is in its long descent to the sun always liable to increase, but its accumulation by new added matter is so uncertain that such objects reach us of all sizes, from the invisible to

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* If there is no atmosphere on the sun, the aerolites fall whole upon his surface instead of being spread out in the primal atomic state, as is their condition when they encounter the atmosphere of the earth.

the most brilliant meteors we behold. In very rare instances—perhaps not one case out of hundreds of millions—the aerolite becomes fortuitously so enlarged that its whole matter has an attraction within it stronger than that of the sun reaching it, at whatever distance it may be in, and at the same instant, the total bulk of its atomic matter—its matter, although condensed together, is still in the pure atomic state—is acted upon in precisely the same manner, only on a larger scale, as the grain of dust which was the first beginning of the sun. Hitherto the collection of atoms was only an aerolite that could have no rotation, because there was no common bond binding together all its parts—in short, a quantity of matter fortuitously brought together by revolving motion, not yet compressed together out of its primal condition. The moment, however, it gets so augmented that the attraction of the whole is stronger than that of the sun in the position it holds, then its attraction turns towards its centre. It was before a loose unconnected quantity of matter, and now all at once mutually press in towards the new common centre, in its own heart, in the lowest degree transforming it into a solid body. The sudden reversion of attraction into itself imparts to it an axial turning motion,—impossible for it to escape,—a rotation quick or slow, and in whatever direction the weight of its exterior acts most strongly on its equilibrium. In regard to time, the whole operation is as quick as lightning; it changes the aerolite or falling matter into a world, and by the same material action its attraction centres inwards and its equilibrium is turned. Thus it has imparted to it, in common with all other bodies, that motion by which the worlds have been moulded out of matter, as it has continued to be created from the beginning.

In an early portion of the work we have pointed out—so far as secondary bodies are concerned—the possibility that many of them may be indebted for their axial motions to the small bodies, all being at the first nearly equal in size, striking upon each other when they were mutually incorporated, the impulses given having had the natural effect of turning their equilibria. At all events, under whichever of the two conditions—the principle, be it remembered, may apply to planets but not to suns—rotation was first imparted, when we consider these two causes which universally acted upon bodies at the instant they became attractive centres, or immediately after, we suppose it next to impossible that any independent bodies, with the exception of comets, can be without this motion. At least, all created bodies, so near that we can observe spots on their surfaces, are proved by the motion of the spots to rotate, and among them we can include the sun himself. He turns once round in twenty-five days of our time, a rotatory motion comparatively slow, yet it meets the purpose of planetary formation and government just the same; but with this important modification, that the quantity of matter in the planetoidal state left behind is less in the same degree as his rotation is slow. This causes the planets of a system to be nearly in the same

have not a barren space, a void without a world, is enti
to the fact, that the first condensed particle simply turn
no doubt at a slow rate, but sufficient for the purpos
then only a tiny particle, but yet a governing body.
sole monarch in this spot of the cloud, and just so
attraction spread, the ancient fluid within such limits w
to it in the two-fold sense at the same time of both
round and gravitating to it. All matter must gravitat
bodies most strongly attracting it, except it attains ma
have attraction within itself stronger than the same forc
it from without. Such is the true state of atomic ma
all conditions. It being infinitesimally small, any
draws it in, and as the body attracting it turned on a
matter how far its attraction reached, all within revolve
This spreading force extended still wider until the ent
in its present outlines was embraced; the ancient fl
throughout, under the rotation of the central orb, rev
the worlds were begun.

The whole of matter within the grasp of a govern
whether it may be atoms, aerolites, planetoids, or wo
revolve round it in the same direction as it turns on
which in the case of our sun always was from west to
as matter in no two positions revolve round at the sam
describe by their orbits the same exact figures, the cre
the infant sun had hold of either overtook or was overt
condensed into particles; and these by the same opera
through their revolving motions—recombining, a large
gravitated into the new centre in a grosser state i
descending in its atomic invisibility. By these opera
sun, which had so small a beginning, was by rapid strid

re constantly liable to combine ; and in one case out of perhaps undreds of millions, quite sufficient to meet creative design, n aerolite becomes so far enlarged, by fortuitous combination ith others, as to become a planetoid. Whatever aerolite had he earliest precedence was the first secondary body which ttained independence in our system.

In the meantime, by the constantly expanding attraction of he sun into wider space, other planetoids in like manner were oming into existence over the expanse, precisely on the same rinciple as aerolites are every day maturing into planetoids at resent, only on a vastly larger scale. It need hardly be added, hat at this dawn of the formation of the worlds the sun had no more power to draw them in, the instant they became endowed with what we may term planetary life, than at present. When once formed, they lost the falling, but retained their revolving motions, and while they existed were, as subject bodies, in as ndependent a state in relation to the sun as the largest planets.

To briefly explain these important principles as they always ct, but more especially as they affected the first budding of the lanets of our system into existence, let us observe that all minute matter then, just as now, gravitated to and at the same ime revolved round the sun, and these motions led the atoms to oin and increase into aerolites, and they in like manner were iable to be constantly added to by being led into one another. Some odd aerolites thus became so enlarged that they had ttraction in their totality of matter stronger than that of the sun eaching them, in the positions they were in. Under such conditions, the attractive forces inherent in them turn inwards to their centres ; at that instant, scientifically speaking, life was inhaled. They were independent bodies, and the sun had no more power o draw them in while he held this gravitating power over all other matter in a lower degree, from atoms up to the largest aerolites. It is from these latter formations his whole bulk has been made up from the beginning. These operations are now going on in their fullest vigour,—they rest on the hardest facts,—but at the first they must have been on a far larger scale, during he time the infant sun was stretching out step by step the arms of his power, deeper into the endless luminosity around, dragging nto himself by the force of his attraction the continued increase of creation generated for millions of years. As his system spread wider, planetoids even in a vastly greater degree multiplied up to he time his power reached its remotest limits. These limits barred him in from extending his sway wider ; for now the mists had all melted away into the bodies of the border suns, and as rontier opposing forces they made it impossible for his power to spread wider. When the system had reached this stage of its development, that is, to the fullest expanse to which it could ever afterwards spread out, let us take a view of its then actual condition throughout, under the supposition that he gained power over the total area by one operation, as at the initial step of his formation. This was far from being true; but for the present it must be viewed in this light, so as to give a more comprehensive idea of the chaotic state of creation, or rather the beginning of those worlds which now thinly dot the system.

The entire space, which before the sun obtained sway was a luminosity, is now cleared of the ancient fluid, together with the systems surrounding us. Had it been our privilege to gaze on starry space as it then existed, instead of being a monotonous luminosity as it was prior to solar formation, we imagine the appearance would have been a broken sky, with the blue prevailing, sprinkled over with innumerable spots and patches of fleecy clouds, within which regions of our Milky Way still remained, not yet gathered into suns. Since then all have disappeared, down to the nebulæ the telescope still brings to view. There was then within the system a sun, made up of nearly the whole matter created over the entire expanse for the millions of years previous to his formation, and the magnitude he then had attained is to be calculated by the age of creation at the time. If only one-fourth of the creative period had elapsed up to this time—on the assumption that creation has always progressed at a uniform rate—he then must have attained one-fourth of his present magnitude; had it taken place midway in creative time, he would have been of half the magnitude; and if still later, at this turning step of his existence, he would have been in the same comparative degree larger. It is, however, not given us to know these things, either as to the time creation has lasted or the relative periods when marked events in the development of the system occurred. This we can affirm, that our sun and system rank with the stars and their systems, and being thus one of the great suns of our firmament, to have attained this highest step of grandeur he must have been among the first in lonely solitude to form in the cloud at a time far back in our creative epoch. Another long stretch of time had to elapse from being a particle up to the period his dominion obtained its broadest expanse, and compared to the age of creation this consummation may not have been so very far back. Be that as it may,—it is a question we can have very few facts to conclude upon,—when he had thus stretched out his attractive power to its fixed limits, it remains for us to consider planetary formation in the most extended sense, still under the false assumption that his attraction became supreme over the whole expanse without any retardation of the grand operation as it first began. This was by no means so, but the subject must be treated in this light, that, if possible, a broad and clearer idea of the formation of the subject bodies of the system may be imparted.

CHAPTER XXVII.

CREATION IN THE CHAOTIC PERIOD.

SOON after the power of the sun expanded beyond the initial step of his formation out of the myriads of aerolites gravitating into him, odd ones became enlarged to planetoids, or rather independent worlds in miniature, and as the system gradually spread these liliputian bodies enormously increased in number through the different latitudes up to the utmost limits. Here his hitherto spreading power became fixed and unchangeable for ever. If this had been one grand operation, such as the first step of his formation was, say ten or a hundred thousand years—a length of time compared to the creative period exceedingly short—the scene over the expanse would have been somewhat as follows :—

A grand and glorious body in the centre, but of lower magnitude than at present, and with light in the same degree less intense, composed of the whole matter created within his precincts up to the time, except the planetoids left behind in millions over the various latitudes. If there had been eyes then to look, they would—as all such bodies are at present—have been invisible, mere handfuls of matter, not even yet rounded in shape, and compared with the parent body in the centre, if taken in the aggregate, not perhaps a millionth part. These primal planetoids, formed out of the ancient luminosity, were of necessity different in magnitude according to the latitudes they were in ; they were larger near the sun, where his attraction is stronger, and gradually became smaller as the same force in the greater distance was weaker. To explain the principle more clearly, these lowest-sized independent bodies—if not fortuitously enlarged above the planetoidal standard—are always large or small according to the strength of the solar attraction in the position they are in. Take, for instance, that space from the earth inwards to the sun—his attraction within it is, according to remoteness, in the same degree stronger than in other portions of the system ; planetoids, therefore, or rather the lowest class of independent bodies, looked at in themselves, must have been and are of considerable magnitude within that narrow area. On the other hand, within this confined space so near the sun, we must look upon these formations as being rare ; it may therefore be that at the first stage of planetary formation, comparatively few of these embryo worlds revolved over our low solar latitudes. Passing beyond Mars and the asteroidal zone, we come into the regions of Jupiter and Saturn. From this favourable position in regard to the expanse of the system, it is natural that planetoids should there most abound; but in these higher latitudes, over which this lowest class of independent bodies must then have been innumerable, they were and are as much smaller as the attraction of the sun in the greater distance is weaker. Thus, as we advance step by step farther from the sun, the planetoidal formations were in every higher latitude smaller, until the outer boundaries of the system are reached—which at that early period were the points where the attraction of the sun died out to nothing—and there the simple particle or grain of dust was large enough to be a planetoid or independent body.*

Such, we suppose, was the condition of the system throughout, or rather would have been, if the mighty work had been one short operation. The sun was near the centre, and in the light we look on the heavenly bodies, was the only one properly so called, much as he is at present, but smaller, and with innumerable planetoids revolving round him in all the latitudes. They were large and comparatively few near hand, in the mid regions of his rule immensely numerous and smaller, becoming still smaller in the remoter space, ending with the size of insignificant particles. These millions of planetoids were in reality independent worlds, which, if they had so continued, creation would have been in vain, as they would have been for ever too small, and therefore unfit to live upon. The sun, however, still laboured on by his axial motion, a mighty central wheel that worked and is still working the great machine. Beginning as a speck of matter, but gradually enlarging into enormous magnitude, by the force of his attraction he collected the atoms which were inert in space, and through his turning they were in part held back and accumulated into tens of thousands of these worldlings. The same turning of the great wheel continued—after being raised to planetoids—to collect them into each other, and thus in the end raise the very few secondaries which would be permanent to degrees of magnitude fit to live upon. Thus the wondrous array of small unseen worlds all obeyed the rotatory wheel of the sun, going round in harmony with it as the acting force from west to east, and became inclined up by the same force of motion on or nearly on a common plane, each one moving round its own independent orbit of a compressed shape peculiar to itself. These millions of orbits had therefore to cross each other at myriads of intersections, and moving, as they must do, all in the one direction, they overtook or were overtaken by one another. By these mutual incorporations, asteroidal magnitude in some cases naturally followed; and of the bodies which were fortuitously raised to this step of approach to respectable magnitude, some had a reasonable prior chance of eventually becoming the primaries, or at least lunars of the system. In short, at the first start, all the millions of planetoids that so far escaped the power of the sun as to be left behind, had each one about an equal chance of itself becoming one of the primaries, or in a lower degree as an attendant; but, with the exception of the asteroidal zone, there was within the system no room for more than eight of the little planetoidal worlds to remain permanent;* but the distinction could only belong to one planetoid, as the representative or first beginning of each primary. In other words, out of the millions of primal planetoids born out of the mist, only the small number which were the nuclei of the few great subject bodies of our system were destined to remain permanent; all the others, without distinction, were in the earlier stages of their formation swallowed up by the few that still and always will remain.

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* It should have been observed beforehand that the total matter of the atomic period of necessity centred into the sun, except the millions of planetoids which the grand operations gave birth to, and which of course, when once formed, the sun had no power in common with other matter to draw in. These planetoids, through their revolving motions, became mutually incorporated, and in after time were all united as separate bodies, which were the nuclei of the eight planets and their moons. Hence the necessity of showing the operations which first formed them.

As one example, in the latitude of the earth several hundred planetoidal formations no doubt took place out of the mist, each one of which had a certain chance of being the real one, the earth itself. They severally revolved round the sun on their respective orbits, and as these figures in that primal stage of their formation

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* It is a startling assertion to make, that there is no room in the system for more primary planets than the few which actually exist within it. Notwithstanding, we, with unshaken confidence, affirm it could be proved, by the soundest scientific evidence, that if there were free room for thousands of primary planets, they would—as small as they would be numerous—actually now be in it. The natural operations at work mould new worlds as planetoids continually, and just exactly that number, neither more nor less, remain permanent—of course the primary planets of suns, including their moons—that have room for their movements, in whatever part of the universe they may be in. The secret for there being room for so few in so great an expanse as our system rests upon the fact, that a smaller body cannot remain permanent which intersects the orbit of a larger, for at some time or other, be it long or short, they are sure to come into conjunction at or near one of the intersections, when the smaller—if not satellised—must yield to and become part of the larger. Not only so; but the attractive spheres of the primary planets, in their motions round the heavens, must have room at all points to revolve free of each other. This they all have—the planet Juno, for so far may, perhaps, be put down as an exception—hence they, as the highest class of secondary bodies, are exempt from the perils of becoming obliterated by incorporation with other larger planets.

The plans of the system, as printed in most all books, teach us to believe that there is ample room for many more orbits to play free of each other; but a moment's study should inform us, that the various orbits are not drawn in any publications in their true relations to each other; they therefore lead the minds of students astray.

In all pictures of the system, each orbit is represented as a circle with the sun in its centre, and one orbit is drawn in relation to another, and indeed in relation to all the others, as equidistant throughout. Such are the ideas taught by pictures in all the schools. Nothing could be more misleading, for were very eccentric—some much more so than others—and as they all moved in one direction from west to east, these hundreds of planetoidal orbits intersected at millions of points. Whenever they came upon each other, at these crossings, the smaller in all such cases became incorporated with the larger. The particular planetoid which was the new earth, must have been among the first that got so enlarged, or it never could have taken the commanding lead, to incorporate all the others—the moon only excepted—into itself. However, it so chanced that the terrestrial planetoid—they all had about an equal chance—took the lead; for, in the race to victory, it was the fortunate one first to get enlarged by two or more inferior planetoids uniting with it, and thus at once by its increased magnitude it became invested with an attractive sphere wide enough to immensely increase its power over its fellow planetoids. By this, and not its increased magnitude, it was enabled in its infancy to appropriate all others within reach into itself.

The wonderful effects which attractive spheres had—and still have—at this early period, may be explained as follows: The bodies or handfuls of matter left out floating over the system, when the sun was being formed, were of course all planetoids, which, we need hardly repeat, are bodies that suddenly became independent, or rather free from the gravitating power of the sun by being fortuitously enlarged into magnitude, bestowing upon them inherent attraction stronger than that of the sun reaching them in opposition. In short, the attraction inherent in them turned inwards, the unerring mark of indepen-

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the sun is not in the centre of a single one of the orbits, and in some cases his position is a third or fourth part from the centres, and the orbits instead of being circles, as represented, are in the same degree oval. If all the orbits were drawn in their proper shapes, with their actual relations to the sun and each other—a task, according to present knowledge, perfectly practicable—by consulting the true picture, it would be found, all things considered, that there is no independent room anywhere left for more primary planets; for if there were room, they would most assuredly enliven us with their presence.

It may be argued that in the intervals existing, more especially betwixt the four minor planets, there is ample room left for the free motions of the orbits of additional primaries. So there is, if a new formed body had an orbit as circular as the orbits of the above planets; but it is well known, or at least should be known, that all planets—at least until they rose above the status of asteroids—have had orbits very eccentric; it is this early condition of their formation which we must take into account in showing that there is no room left for more primaries to be developed. It is by reason of their imperfect rotundity during the early periods of their formation that they ran on figures so very eccentric; consequently, while there is no doubt that unseen planetoids are revolving in the intervals betwixt all the planets, it is impossible that any one of them can permanently remain, and gradually grow to perfect roundness, and from this cause escape and be primary planets. In a perfected system they can never be improved into the true mould, and without this their movements continue so eccentric that they must cut the orbits of one or more of the primaries. It is therefore their universal fate, in the present condition of creation, to fall into and become part of whatever planet or planets may first lay hold of them at any of the intersecting points their motions lead them to pass over.

dence in bodies, and when so constituted, this lowest class of secondary worlds have their attractive spheres; but as the attraction is to their own centres only at the turning point, in opposition to that of the sun, the spheres of rule surrounding them extend so little above their surfaces as to bestow no power upon them to captivate other objects of matter into themselves. The earth, as one of the primal planetoids, was in this state, with its sphere of attraction necessarily very contracted, and thus far its weak condition was in common with the others. While they, in this state, crossed and recrossed each other's paths, they could not mutually incorporate without striking straight on by their motions, events which, considering the wideness of the space and the smallness of the objects, were likely to happen very rarely; but among so multitudinous crossings at so many points, direct collisions were not impossible.

Our earth must, in its own latitude, have been one of the first among the number which was hit straight on by another, and the two becoming one altered its relation with all the rest. The change constituted it a leader among the little ones, destined in time to swallow them all up, not by its enlargement, for this in itself could have had little or no effect, but by increased magnitude an attractive sphere of its own spread from it to a distance equal to the stronger attraction it as a body had thus acquired. So far as its attraction in a predominant state now spread out, the expanse became a target by so much wider to catch the others. For there is an unknown law in the formation of secondary bodies, that matter, in whatever condition it may be, if it hits or is led by its revolving motion—and it must be constantly kept in mind, revolving motion is common to all matter under the sun, from atoms upwards—into attractive space of secondary rule, if not constituted to be satellised, must inevitably fall into and become part of the planet or secondary body within whose attractive sphere it may be. Suns have no such power, or else all secondary formations would soon cease to exist; but the evidence is too universal to leave any doubt that secondary bodies have this unknown power. It was by such power the earth attained so wonderful an influence over the other planetoids, to their ultimate annihilation as distinct bodies. The power simply consisted in its prior investment with an attractive sphere. The wonderful effects these invisible attractive spheres surrounding all secondary bodies produce, and their agency in planetary formation, may be made somewhat clearer by the following calculation. Let us suppose the earth when a planetoid was only one eighth of a mile in diameter,—if it was more it will not affect the reasoning,—as it then had no attractive sphere wide enough to invest it with additional power, it only presented that breadth of target to be hit; but it was most likely the first one in its own latitude enlarged by direct collision—events, as above observed, that rarely take place. It at once took the lead, by its attractive sphere, of all the others, and soon got enlarged by the incorporation of another and another, till it became half a mile in diameter, or several times larger than when only the lowly planetoid. Its attraction by the increase, of course, gained at least four-fold greater strength as a body, so that it must have had a sphere of attraction somewhat spread out, and therefore predominant over that of the sun to a little distance in all directions. We will make a very moderate estimate in supposing the radius out was five miles—it may have been more or considerably less, as we have no means of correctly judging—there was at all events an attractive sphere of some expanse, investing it with power, and if it was ten miles in diameter, it became a net to lay hold of the other planetoids that much wider than when it was in the lowest sense itself a planetoid, practically without an attractive sphere—its body alone, the target, only one-eighth of a mile in diameter. Measuring the one expanse by the other, that of the earth with its new attractive sphere was in disc measurement sixty thousand to one, and exactly in the same degree it became invested with greater power over all the others in laying hold of and incorporating them into itself. In other words, the particular lucky planetoid among the hundreds, perhaps thousands, that was the nucleus of the earth, by becoming through their revolving motions united with two or three others, and thus by anticipation invested with an attractive sphere, had bestowed upon it chances sixty thousand to one in its favour, compared to most all the others in netting into itself the scattered planetoids which by their orbital courses at any points touched on the line of space it and its little attractive sphere revolved round. All that by their motions stumbled into the terrestrial sphere of attraction were inevitably incorporated with the young, but at this time fast growing primary —the earth.

In the meantime, amongst such a multitude of little worlds, other combinations at different positions were taking place in like manner. Nature in all these separate centres worked for the mastery; but our globe having got such a commanding lead—which any one planetoid would have had that first became by increase of magnitude invested with an attractive sphere wide enough to be of grasping power—it was impossible that any one of them could so increase as to outrival it. When, therefore, the time came that these minor combinations, or rather bodies springing up in a much lower degree, were by their motions led into the terrestrial attractive sphere—by this time wide in expanse —they in like manner became incorporated with our planet, as the great leader in the midst of the minor creations around it. Thus all had to succumb and become part of the earth, up to the time that the thick crop of planetoids touching our latitude, the primal children of the mist, were all incorporated into it. The work was never perfected while any one of the original orbits remained that intersected the earth's path round the sun, or even touched upon any part of the space its sphere of attraction passed round.

How long, it may be asked, did it take the earth to bring all the planetoids created out of the mist into itself? Our unhesitating reply is, that before the last one was laid hold of, millions of years were likely to pass away; but in regard to every separate planetoid in connection with its revolutionary motion, in one sense the length of time depended on the difference of their respective annual periods. Suppose there had been betwixt the earth and any particular planetoid the difference of a month* in their respective revolutions, they actually came into conjunction with the sun once in twelve years; but except the conjunction took place at or near one of the intersecting points, another long period—in fact, twelve conjunctions—had to pass before a chance of incorporation would again occur. Taking the most favourable view of the case, that their orbits leaned little out of the same plane, the shortest possible time it took for the incorporation of the planetoid with the earth would range betwixt one and seventy-two years; but with so long a difference in their times as a month, there were ten chances to one of their escaping each other at the intersecting points, so a much longer time was likely to elapse before they would be joined into one. If we again take for example another planetoid, which differed in its yearly time only a single day, the two could only have been in conjunction with the sun once in 365 years, and as 182 conjunctions were liable to be repeated—all depending on the relation of the two bodies at their first start—before the planetoid could be laid hold of near one of the crossing points, fifty thousand years might elapse. As very few, in our latitude, differed in so low a degree in their yearly times compared to that of the earth, we may reasonably suppose, with very odd exceptions, that the chaotic period was practically at an end—we are reasoning only on planetoids which revolved on or nearly on the plane of the earth's orbit—so far as the earth's position is concerned, at the end of the foregoing period; but the work would be incomplete while one of the primal bodies was left, and among such a multitude there may have been some that were so nearly at the same mean distance, as to differ in their annual rounds from the earth not more than a single hour. If there were any such, they were liable to escape incorporation one and a half million years; and it is possible in some cases the difference may have been even less. Viewing the question in any light, the conclusion would be no exaggeration, that it took the earth millions of years to lay hold of the last one of the first formed planetoids which nature spared from the sun, to raise it in its first step of magnitude as one of the primaries.

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* It might be considered that a month's difference in their years would cause the interval betwixt the two orbits to be so wide that the planetoid would move free from the power of the earth; but the very eccentric orbits of nearly all small bodies may lead them to a mean distance twice as great, and yet be in the power of larger bodies. It meets the necessary conditions if the orbit of the smaller touches at any point the track swept round by the attractive sphere of the larger.

Thus far, we have submitted a brief description of the early formation of the secondary bodies in the system, on the broad basis that throughout it was one grand operation, which in a short period spread over the whole—an assumption which violates no sound principle, as each planet, in its turn, began to be built up by the planetoids surrounding it, after the manner described, when the gradual expanse of the system had reached its own particular latitude. Having, however, set out on a false principle, it may be here corrected, by observing that, instead of such a mighty work being almost simultaneous over the whole expanse, millions of years may have intervened from the time the first to the last of the eight primaries were formed. We suppose they originated in succession one after the other, from the sun outwards; but it is possible that three of the minor planets nearest the sun, or at least two of them, came into being almost simultaneously, while ages most likely elapsed in giving birth to all the others, long or short as they are near or remote.

As has been repeatedly observed, the sun had first to begin as a particle, which rapidly increased to the end of the first grand initial step of his formation, which consisted in the concentration into himself of practically the total matter suspended inertly over a certain area. This area, whatever may have been its expanse, included the whole of what was then the system, and to whatever distance that may have been,—we suppose, for obvious reasons, it was no wider than the lowest order of minor systems. Its real expanse at the end of this primal step is, of course, not given us to know; but even if it reached as wide as the terrestrial orbit, or say a radius of a hundred million miles, it would only be a six-thousandth part of what we imagine the total measurement of the system is at present. If all these particulars at the beginning held good, the three minor planets nearest the sun must have come into being nearly at the same time, leaving all the others, at long intervals, to originate in due order. The sun was the first material power to begin the advance, and very soon conquered the original extent of system in the primal advance; but when this, the first step of his power was reached, the progression of his system afterwards was gradual for perhaps a long succession of ages, up to the time the mists were dissolved into the border suns; their dividing lines fixed for ever the limits of his hitherto spreading power. This slow expansion of our sun's supremacy naturally caused the superior planets to come into being one after the other in succession, according as they are remote. Thus, when Jupiter was but an insignificant planetoid, the three primaries nearest the sun had had time to gather in the multitude of planetoids which nature spared them to begin with, and were likely advanced in magnitude at least to the dignity of asteroids. In turn, Jupiter rose to considerable magnitude before the luminosity was cleared away from the space round which Saturn's orbit is now traced. After this manner, the dominion of the sun gradually extended, and the primary planets in their positions originated, as described, at times wide apart, till the most remote one came into being as a planetoid after perhaps millions of years had passed away since the primal existence of the sun, and when no doubt the minor planets, which originated at a much earlier period, had by this time increased into respectable magnitude. From that to the present they have been still increasing, most likely at a uniform rate, and the same applies to the other bodies of the system, including the sun himself.

What is more, the operations which are going on before our eyes incontestably prove they had a beginning. Beforetime there was nothing which mortals could feel, hear, or see. The mighty work has been gradual, and we suppose continued at a uniform rate for perhaps hundreds of millions of years, instead of, as many believe, bounding in an instant into their present glorious perfection at the fiat of the Almighty. We are in the midst of the progressive work, and if asked how long it will continue, our unwavering reply would be: Just so long and no longer than creative increase will be useful. Nature, which in all things proves Almighty design, does all things well, and philosophers need have no alarm that creation will run to excess by lasting for ever. The Mighty One caused it to begin, and it will just last until His purposes concerning it are fulfilled, after which all materiality, as sure as it began, will come imperceptibly to an end; but how or by what natural means, it is as little given us to know as the generation of matter out of nothing, which is still continuing. Whatever nature produces, nature dissolves. The sun, moon, and stars are produced by nature, and like all other natural productions this is their growing season, and they will grow on to maturity; and there is no doubt long after the present—a time vast almost beyond conception, but yet only as an instant compared to eternity—they and all their wonders will have passed as shadows out of sight.

CHAPTER XXVIII.

LUNAR FORMATION DURING THE CHAOTIC PERIOD.

LET us now make a few observations on lunar bodies. In number, as compared to the primaries, they are about two to one, and most likely the proportion is higher, but from distance and other causes, if a greater number exist, they are so far invisible. Like all bodies they began as atoms, they increased to planetoids, the lowest state of independence, and like other bodies grew up to their existing magnitudes during the course of time, by laying hold of new created matter, wafted by revolving motion into their attractive spheres after the manner of planetary formation. There is this difference betwixt the beginning of the two classes of bodies, namely, that planets necessarily sprung from the collecting together of the first planetoids which were left behind floating over the system, when the sun was being made up out of the ancient fluid matter; whereas lunar bodies were liable—but, as we shall see presently, not likely—to originate at any subsequent period. Taking this for granted, it is necessary to inquire whether lunar bodies generally originated simultaneously with the primaries, or are in some cases creations of more recent date.

In the first place, from the operations still going on, and which have continued so from the beginning, we would be justified in the conclusion, that they may have been formed at the same time as the planets, or at subsequent periods down in creative time; for little and invisible worlds are being constantly formed, by aerolites becoming overgrown, and thus raised for a time to be independent bodies. These have all the attributes of the primary planets, however small they may be, and as they are continually being formed, if they could only keep free for a period long enough, before stumbling into the merciless power of the primaries, it might be possible for some among the lunar bodies to have originated, and attained that rank more recently than at the beginning. Nature so works, that moons may have sprung up at any period; but when everything is considered, it seems to be a moral impossibility that, since the system became organised, any planetoids could have attained near to lunar magnitude, before being laid hold of and incorporated with one or other of the primaries. The difficulties lie in the initiatory step of enlargement, as planetoids are bodies without attractive spheres wide enough to captivate and ensnare other matter, or to lay hold of each other. The only chance of union betwixt any two such bodies—and thus by their united magnitude constituted as one, invested with some degree of power, however little—is, by their motions, at the points of intersection leading them direct on to each other, and the chances of such small objects doing this, although they are comparatively numerous, are so slight that in the existing condition of things they must rarely happen. Yet even now collisions betwixt planetoids moving direct on are not impossible, and when they do take place, if there is a near equality of magnitude betwixt them, they cannot mutually incorporate. When incorporation does take place, there must in all cases be such a difference betwixt the two, that the larger can act with such power over the smaller, that at least at the point of contact its attraction reaches all the parts with greater force than that inherent in the body being incorporated. The attractive centre is then by opposing stronger attraction taken from the smaller, and for the want of this natural bond, which preserves all creation, it at or before contact becomes loose throughout, and falls to pieces on the larger as so much incoherent sand, while the latter retains its solidity and central life unchanged. In short, when any two bodies, be they big or little, through their revolving motions become incorporated—it is by and through revolving motion all secondary bodies have been formed—to produce the result they must differ considerably in magnitude. If both are nearly equal they each, even at the point of contact, retain their attractive centres, so that incorporation betwixt them is impossible. When rare occurrences of the kind do happen, they harmlessly shove each other aside as so much shadow, imparting the one upon the other not the least injury or concussive force. As bodies, taken as wholes,—not materials on their surfaces,—they are not the weight of a grain of dust, and consequently no force can be imparted by their collisions. On the other hand we repeat, two bodies colliding, if one be considerably larger than the other when at or near the point of contact, all the materials of the smaller are acted upon more strongly by the attraction of the other, and the instant the change takes place, they—the whole materials of the falling body—turn towards the larger as their new common centre: in short, the bond which hitherto united them together as one to their own native body is broken, and the total descends on the larger one in a loose helpless state, the latter still retaining intact its own attractive centre and solidity. It receives a certain measure of enlargement but no serious injury or disfigurement. This is the true state by which bodies become united together, and no matter what the smaller body may be, whether a diminutive aerolite, planetoid, or large globe about to be transformed into a ring, at or before the eventful moment, gravitation towards the larger must be imposed upon its materials, for otherwise union betwixt the two could not possibly take place.

Taking these views of the subject, as a whole we may well conclude, that in the matured state of the system—in the sense implied, we call the system matured from the time all the planetoids formed out of the mist were in their relative positions collected by their revolving motions into the eight primaries*—in rare instances if they did hit straight on, when of nearly equal magnitude, no union could take place. Still the greater number of planetoids differ in sufficient degree to incorporate, and in the extremely few instances they hit straight on enlargement in the same degree takes place, yet on so limited a scale it is next to impossible that any of the known bodies of the system could have been so far enlarged by the creative operations at work, if they originated any time posterior to the chaotic period. There is little doubt planetoids even now are being formed in thousands within the system, and they all as little worlds, if permitted to remain forever, would in the end become bodies somewhat enlarged. Yet, broadly looking at the system, we see the primaries, at natural distances, gliding round the heavens with their wide attractive spheres that lay hold of and incorporate all bodies great and small which stumble by their motions within their embraces. On the other hand, in relation to them, we know that such small bodies as planetoids most likely have orbits so greatly eccentric that it is probable, in most cases, they cross over the orbits of more than one of the primaries, and with such relations, we conceive it to be an impossibility that a single one in any portion of the system could have been permitted to exist without being laid hold of, long enough to attain a magnitude even as large as the smallest visible asteroid during any period since the system was reduced into its present order. The question viewed in this light, we are justified in taking the first origin of lunar bodies universally as being coeval with that of the planets.

With this assumption, we can go back once more to the beginning, and broadly view creation at that early period, and judge how natural it was for the planets and moons, although not as yet linked together, to have co-existed from the first; and in judging of the absolute certainty of both classes co-existing from the beginning, we must keep in view that the infant sun at the time was drawing into himself, from a luminous fluid state, the creative increase of perhaps many million years, and the greater the quantity held in suspense over the expanse, in the same proportion were the planetoidal formations left behind, at least thousands of times greater in number to whatever existed in any after period. These myriads of planetoids revolved in every latitude in succession, as it became cleared of the mist by the spreading attraction from the great centre. From such a chaotic state of creation we are therefore enabled to judge what may have been the condition of our own particular latitude, when its luminous matter had just gravitated into the new sun. It was left thickly sprinkled over with these primal secondary formations, all revolving round on orbits so very eccentric that some of these small invisible bodies may not have at their perihelions been more than the latitude of Venus from the sun, while their aphelions stretched out perhaps as far or beyond the orbit of Jupiter. Such we suppose were and still are the elongated nature of planetoidal orbits, so that while they undoubtedly differed very much in eccentricity, as a general rule they were so much so that a great many of them were liable to be caught when their times came, not by one particular primary, but by whatever planets their movements first stumbled upon. Even in the present matured state of the system there are no doubt numbers of planetoids revolving occasionally in our latitude unseen and unknown; but where there is one now, when the ancient fluid was newly cleared away, there were thousands, and thus the materials were spared from the grasping power of the sun in abundance to make a beginning, not only to the primaries, but likewise to all the bodies which were to become their satellites. They were begun precisely as the primaries, but the latter having had in the race to secondary supremacy the first step of ascending magnitude bestowed upon them, they could never be outrivalled by the bodies in the next lower degree, and thus some of the latter had to submit to lunar subjection under them.

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* Astronomers generally, in a certain sense, reason on all secondary bodies excepting moons as primaries, in which case, instead of eight, there would be above a hundred planets in the system. This work defines a planet to be a body whose orbit runs clear from intersecting the track of another larger than itself. No matter how small it may be, if so independently related, it ranks in the highest list of secondary bodies as a planet, and therefore a primary. As far as is yet known there are only eight secondary bodies, excepting moons, free in their courses from intersecting the orbits of others larger than themselves, and from this cause these only rank as primary planets. There is one other body, Juno, may be almost an exception, but she is disqualified as a primary by reason that she slightly trespasses within the orbit of Mars. Were it not for this she would actually be a ninth primary in the system, and until natural operations mould her course sometime in the remote future to run free from her perilous relations to the above primary, she can never take the high rank of being one of the planets.

The principle of lunar formation and final subjection may be made somewhat more familiar by taking the single example of our earth and moon, when at first they were both primary bodies. When the earth, as the lucky one amongst the number, became first enlarged from a planetoid so as to extend out for some distance an attractive sphere, this prior lead enabled it to outstrip all the others and become the primary, and in due time, with the one exception, to incorporate them all. While it thus went on ahead and enlarged, different combinations among such a multitude of planetoids were necessarily springing up in a lower degree. It could not be otherwise at the first, when all secondary formations were nearly equal in magnitude and so vastly numerous,* but that combinations in many instances in such a state of things must have taken place, in the meantime the earth still holding the supremacy in growing magnitude. As the greatest it laid hold of the smaller, and no matter what state of development they may have attained, whenever their movements led them to stumble within its attractive sphere, and therefore wholly at its mercy, it was their fate to be incorporated. Among them it was in accordance with nature that one, two, or more became separate centres which increased, compared to the then small size of the earth, to lunar magnitude and even higher. The moon was undoubtedly one of these few—the next step lower in degree to the earth—she may not have been of the greatest magnitude, yet she must have been the largest, indeed the only one in the terrestrial latitude naturally constituted to be preserved under secondary rule. They, for example, had to succumb to incorporation which had rapidity of rotation nearly equal to or exceeding that of the earth, no matter how large any of them may have been, and the same fate in like manner befel those which were too small; for no matter how slow their rotation was as compared to that of the earth, when led to the exact lunar distance, where they would revolve once round for every turn on their axes, they had to fall to the earth, because when at the right positions gravitation—which is fatal to all bodies subjected to it—was from their smallness imposed upon them.

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* Planetoids which now exist in the system are numerous in the same degree as the total matter created during the average life of a planetoid. In extr-

When all these circumstances are considered—connected with creative operations, then on so large a scale going on—the chances upon the whole were very much against the earth having appended to it any subject body. In the first place, it had to be a slower rotating body than the earth, or else when once caught within our attractive sphere, her doom was sealed quite irrespective of her magnitude; and secondly, she had to be large enough, compared to the then small size of the earth, when brought to the point of distance, that she would revolve and rotate once in the same time so as to escape the perils of gravitation. Our moon undoubtedly fulfilled both these conditions, or else we would now be without her presence to make our night seasons delightful; and to obtain this distinction, instead of losing herself as part of the earth, she no doubt was in a lower scale one of the leading centres in the collecting in of planetoids. If other

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rare instances they are so related as to escape incorporation for perhaps millions of years, but the vast majority become incorporated with the primaries most likely in a few thousand years. They are aerolites so enlarged as to be attractive centres, when of course the sun's power over them is at an end in drawing them in by gravitation. From the natural operations which form them, the present existing number of planetoids floating over the system must therefore represent creative increase during the average time they are permitted to exist. Suppose it to be ten thousand years, and the atomic period of creation to have lasted ten million years before the sun was formed, planetoids at the time of his formation must then have been a thousand for every one that exists at present.

centres had then increased to a larger size they were of course quicker in their axial motion, and of necessity became incorporated, or it is possible there might have been others as large or a little larger with somewhat slower rotations than that of the earth, but so fast that when at their right positions to revolve and rotate in the same time, they were so near as to lose their attractive centres by the stronger attraction of the earth in opposition, they in like manner became the victims of gravitation. The moon laboured under none of these defects, for her axial motion was and is much slower than the same motion of the earth. If therefore she then were of any respectable size—and a very diminutive size was sufficient—she was exempt from the dangers of gravitation.

What the real size of the moon was when first joined to the earth as a subject body is what cannot be known. She may have been of considerable magnitude; or, judging from her rotatory rate of motion, when first caught her orbit must have been very near the outside of the earth's attractive sphere—facts which give the clearest proof that she would have been safe from gravitation to the earth had she then been as low as a double planetoid, or any moderate size higher. Such was possible consistent with her safety, but comparing the relative magnitudes of the two bodies at present she must have been at the first very much larger. The expanse of her orbit is an indirect proof of the fact, and that her satellisation compared with the age of creation must have been a rather late event. When caught, for instance, the attractive sphere of the earth had to be wider than her orbit, and to be so wide in opposition to that of the sun our planet then must have been of great magnitude, and as both bodies began simultaneously as planetoids, the moon must have increased in a lower degree all that time. Now, making the liberal allowance that, when the two were first linked together, the one was several hundred times larger than the other, still, considering the then wideness of the attractive sphere of the earth—wider than the lunar orbit—as observed above, it must have then been a large body, and the moon, in the low comparison just given, may when first subjected have attained a diameter of one, two, or three hundred miles—a size, if no comparisons are used, by no means of contemptible magnitude.

That the moon at first was far lower in comparison than she is at present to the earth there can be little doubt, for very convincing evidence could be produced—which we cannot here enter upon—that as creation continues to progress, all governed bodies, whether they be planets direct under suns or moons in lower subjection, gain by comparison over the bodies which rule over them. Thus, if we take an early view of the question, all the planetoids left at first behind over the system by the attraction of the sun—supposing the clearing out of the whole expanse had been a simultaneous work—may not have been a ten thousandth, we might almost venture to say, a millionth part of the total matter then created—the only moiety spared for planet formation, the rest having centred in the sun—yet since then the subject bodies have so far by comparison gained, that in the aggregate they are now about a six-hundredth part of the whole. As planets gain on suns, on the same principles moons gain upon planets. Take our moon for instance, and suppose she is, roughly speaking, fifty times smaller than the earth, as each body must receive a share of creation just proportionate to the expanses of their respective spheres of attraction, it could easily be proved on this reliable basis that the moon instead of receiving a fiftieth part—according to her magnitude her due share—of the whole which comes into both bodies, her present gradual increase is perhaps as high as a tenth part. When we therefore see the great gains—judging from the operations at work—they in all ages have attained, we may rate the comparative magnitude of the subject to the ruling bodies as having at the first been very much lower than at the present. Hence it may be no exaggeration to suppose that at the first subjection of the moon to the earth, she may have been several hundred times smaller—her existing nearer equality being attained through the operations at work from that to the present.

We have yet to consider more fully as to whether our moon and other moons of the system all originated simultaneously with their planets, or gradually came into being during the ages which have since passed. The subject has already been partly discussed, and viewing the question in every possible light it is next to impossible to come to any other conclusion than that they are all coeval. At the outset there were millions of planetoids sprinkled thick over all the latitudes, nearly equal in size, destined to be reduced in number until the few left would have room to run on their orbits perfectly free of each other. The innumerable host beginning on such equal terms, every one had a chance by combination to take a lead, and in the end be advanced to the dignity of a world; but the number which attained so high a standard was very few, only the eight primaries and their moons,* all the others succumbed. No other effects therefore could have followed than that very many bodies attained considerable magnitude, as separate leading centres in various degrees, long previous to the time when the present settled order of things supervened, and many of these lower combinations of matter—as was natural under such operations—thus rose to respectable magnitude, most likely up to the size of the visible asteroids. What, therefore, is more natural to conclude than that all the moons of our secondary systems were subjected from among these earliest formed bodies.

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* We exclude the asteroidal region. Within it creation in its chaotic state still continues and will do so until, by their orbital motions, the numerous bodies over its expanse will be collected together into one or more by incorporation.

So much for the probability of the moons being coeval with their planets: it remains to be seen how very unlikely it was for a single one of them to have been formed in any subsequent period, although the later formation of moons was not impossible. Any moon since formed would, like all other secondary bodies, have had to begin as a planetoid, and coming into being after the present order of things were perfected, the chances it had of attaining any reasonable magnitude were as remote as the planetoids are now fewer in number, compared to what they were at the first—perhaps then a thousand to one. Besides, this is not the only hindrance against any planetoid at present or for millions of years past reaching up to any dignity of magnitude. In a perfected system they run an unequal race, with the broad attractive spheres of the primaries spread out as so many nets to lay hold of them. For we must look upon all such new-formed bodies, or rather overgrown aerolites, as running on orbits so eccentric as to pass over the orbits of more than one of the primaries, and thus through their wayward courses are exposed to double or treble chances of being caught by any one of the planets whose orbits they pass over. For these and many other reasons it is highly improbable that any one of the moons in the system can be of later origin than the planets they are under. We might go farther, by adding that instead of having a chance of rising to lunar dignity, very few new created but ephemeral bodies ever increase in the present constituted order of the system much above the size of the lowly planetoid.

The next leading feature of the system—which we take the liberty of appending to this chapter—is the rings of Saturn, a subject we have dwelt upon in the chapter on annular formation; but there was one particular we were not then prepared to enter upon, namely, the relative time in the creative period these formations took place. We imagine their formation, although not simultaneous, were events of comparatively recent occurrence, and our reason for supposing they were formed late in creative time, is that we take it to be impossible that rings could be formed except betwixt bodies of enormous size colliding upon each other, but as a necessary condition with a very wide difference in their magnitudes. The size of the rings themselves proves that they were moulded out of the spread-out materials of very large bodies, and the body of Saturn could not have been greatly below its present magnitude to produce such grand formations. All these facts prove that creation must have been far advanced to its present state, or else the bodies respectively could not have attained such enormous magnitudes.

Another reason for concluding that the events were of late occurrence, is the fact that no rings could be formed except the body collided upon was so immensely large as to have attractive force on its surface sufficiently strong to impose such a degree of weight on the falling materials as to give them a projective force strong enough for the purpose. The heavier the weight, the force of concussion will drive out the materials in the same degree wider. Comparative weight in relation to colliding bodies might be illustrated more clearly by taking our earth and moon as examples, supposing they were so related to each other as eventually to collide. This was their actual relation at an early period of their existence, the catastrophe being only prevented by the slower rotation of the moon. Let us take them to be two independent planets, nearly at the same mean distance from the sun, with their orbits intersecting, or at least at some points so near that the attractive sphere of the earth could lay hold of the moon, when their movements would bring them thus near to each other. So related, they would be sure one time or other to come together, long or short according to the difference in their years, if their orbits had not a too great lean from each other, and when the collision took place—as we take for granted to fulfil the conditions the moon's rotation is to be quicker than that of the earth—the inevitable result would be the incorporation of the smaller with the larger.

In its approach to the earth, once their motions led the bodies to overtake each other, the moon, considering the relative magnitude of the two, would retain its centre of gravity almost to the last, but just at the point of coming into contact this of necessity would give way in the close presence of the stronger attraction of the earth. It would therefore descend on the latter as a huge globe of loose unconnected materials, the whole rolling as a tremendous circular wave over the earth. With the force of the weight imposed upon them, and their velocity of approach, they would perhaps rebound outside to some distance, but not so far as to deprive the earth of still holding the mastery by its attraction over the entire circular cloud of material spread around. All would therefore gravitate back and no ring be formed.

The description of the moon becoming thus incorporated with the earth is just such a collision as took place in the formation of any one of the rings of Saturn, but when such collisions take place betwixt bodies so small, the forces are too weak to produce annular formation. Not the force of the colliding or smaller body, for in reality it imparts no force, but the attraction of the larger collided upon ; and the real force is the weight of the materials as they descend upon its surface—a weight that is not inherent in themselves, but which is borrowed from the body drawing them in, so that it must be the only source from whence the force proceeds. Without weight no material force can exist, and the body which by its attraction causes the weight is the producing force, and in all cases it must be weak or strong according to the magnitude of the body it comes from. The moon falling upon the earth would be a mighty force, but not the weight of a grain of dust would proceed from the moon herself; all the force would be in the weight imposed on the materials as they were being poured upon the surface of the earth by its own attraction. If the moon had collided with the earth—which when first caught she inevitably must have done, but she was saved by virtue of her slower rotation—her approach would have been with meteoric speed; in short, an aerolite on the largest scale, the velocity of approach, together with the weight of the materials—due only to the attraction of the earth—would have produced a sublimely powerful force that would have ground her dislocated rocks to powder, and spread them into a grand circular cloud, but only a little out from the surface, and all would have returned by gravitation to the parent body. The operation, as observed above, is just what would form a ring, but lacking the one essential, sufficient force. So far as rapid approach is concerned there would be nothing wanting, but the materials would only be of terrestrial weight—far too light to impart to them a sufficient projecting force to send them out wide enough to be a ring. The formation of a ring would be impossible, except the spread-out materials are so wide out as to have collectively a stronger attraction than that reaching them from the planet.

Reasoning in the next place upon Saturn, the force applied to the materials of a colliding world on his surface compared to the earth, would be as much greater as his attraction is stronger. In magnitude he is as a thousand to one; the attraction of such a huge body is therefore very likely powerful enough to make the lightest pinewood bulk for bulk heavier than gold on the earth, and rocky material in a proportionate degree heavier. This is the true key which unlocks the mystery of ring formation. The immense weight of the materials on the surface of such a body gives them by their velocity of approach a lateral projective force in the same degree powerful. The force of shooting out the materials of the ruined world being thus proportionate to their weight, and when we consider they approached with lightning speed, their acquired weight on the surface imparted a projective force perfectly adequate to send them flying thousands of miles out—not through atmosphere, but vacuo. At this distance they naturally had within them before consolidation a stronger attraction than that of the planet in the centre acting upon them, and thus they instantly began to collapse towards their circular common centre into a ring. These effects all entirely depended on the one essential weight, as imposed on the collided materials, so as to give ample projective force which would spread them out in a circular ocean to that expanse where they would be exempt from gravitation back to the planet, and the requisite weight would be impossible except on the surface of an enormous body. All these indispensable conditions are proved simply by the size of the rings themselves, for being great in bulk they could only have been formed out of colliding worlds of large magnitude falling upon another at least in as great a degree larger as the earth is to the moon. These facts all coinciding, prove most clearly that the rings were formed as late in creative time as the measure of magnitude that planet had then attained as a body.

The question now arises, Is it possible that the bodies which eventually formed the rings, mutually intersecting each other's paths as well as that of the parent planet, could have remained separate for such a prolonged portion of creative time? The answer is very plain—their keeping apart depended on two conditions: either that they in common with Saturn leaned more on their orbits from each other during a greater portion of the period,* or else that their periodical times were wonderfully near that of the planet; both causes might have been at work. The former of these causes was by far the more natural, and most likely the true one, but the latter was not impossible. Thus, if two planets which intersected were exactly at the same mean distance, their years to a second would be equal, and notwithstanding their intersections they never could unite by reason that they would always keep their first distance from each other on their respective orbits. On the other hand, if the same two—Saturn and one of the bodies out of which the rings were formed—had been at so nearly an equal mean distance from the sun that there was only the difference of one hour in their years, there was a chance of the two keeping apart for thirty million years. The subject thus viewed, the difficulty vanishes of these two keeping separate for a length of time requisite to attain the great magnitude necessary for ring formation. In short, the two bodies which formed the rings, the seven moons, and Saturn himself, we may look upon as being at first all in common, fellow planetoids among the innumerable others which were left floating on or near that latitude of the system when the mist cleared away. And Saturn, the same as we described the rise of the earth, was the first lucky one among perhaps millions—all having a chance—that rose above its fellows and continued to take the lead. It was possible that some other planetoids might have started simultaneously, and continued on about equal footing, and this to a certain degree was actually the case in the latitude of Saturn, for the rings prove that at least two other attractive centres sprung up, which at the outset were perhaps not much inferior to the leading planet. In the end they attained a magnitude, if not superior at least equal to the average of the minor planets at present, and that they eventually fell upon the great planet was on account of their axial motions being as rapid; and that they existed apart so long without being caught, as already observed, was either caused by their periodical times as compared to that of the planet being nearly equal, or what was much more likely, there might have been a wide diversity in their mean distances, and consequently in their years; yet if their orbits in the early period of their existence leaned widely from that of Saturn, the long spell of independence vouchsafed to them from this cause can be naturally accounted for. Finally, their materials were formed into rings because the powerful attraction on the surface of the planet imparted a weight to them far above what we are accustomed to, giving them a shooting force which sent them out sufficiently wide for the purpose, and once projected out were in quantity large enough to consolidate into those unbroken annular bodies which are so much the admiration of all scientific men.

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* In the early periods of creation up to long after the time the chaotic period terminated, we suppose secondary bodies generally were imperfect in rotundity, and just so far as they differed from the perfect shape natural to them as bodies their orbits were in the same degree eccentric, and in an equal degree leaned from the planetic plane. As time brought them into more perfect shape they leaned less and less until—planets which intersected—they at last came so nearly on the same plane as to enable the larger to lay hold of and either incorporate, lunarise, or annularise the smaller, according as they were constituted and related to each other.

CHAPTER XXIX.

CREATION FROM THE END OF THE CHAOTIC PERIOD UP TO THE PRESENT.

We have thus far briefly traced creation to that important period of planetary formation, the end of chaos. By this time, with the exception of the asteroidal zone, the millions of the first formed planetoids were nearly all collected in the primaries, and the present settled order of the system established. The sun, as he had drawn in nearly all the matter which originated during the atomic period throughout the total expanse of the system into himself, had, we suppose, attained very much of his present magnitude, while the eight primaries were still comparatively insignificant. The four nearest the sun may not as yet have advanced much above the asteroidal standard, and the major planets for so far increased in magnitude, not to a higher level than the minor planets at present.* Such is our conception of what may have been the condition of the system when the primal planetoids formed out of the mist were all save odd ones collected together, and incorporated with the primaries; or at least we suppose this would have been the general aspect, if throughout the whole extent it had been one simultaneous work—a monster sun, perhaps half his present magnitude, and a few worlds so small that each one was invisible from the other. The system outside the great centre did not appear so fascinating as it is now: it was an apparent blank, but it rested with progressive creation to gradually raise these insignificant worlds in magnitude, and finally mature them as fit habitations for the living. And as this work, which we conceive has been going on uninterruptedly from that time to the present, is entirely based upon matter being constantly generated in the atomic state over the entire space of the system, we must once more repass trodden ground by describing the career of an atom during its descent to the sun.

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* We have all through held the planetoids, in the first step of planetary creation, to have been millions, and the word myriads would better express our meaning. It may, therefore, seem inconsistent that they were so innumerable, and the planets so small when all were incorporated into them. However, a better conception of what may have been their number may be had by supposing the planetoids themselves to have averaged each a mile in diameter. It would take 512,000,000,000 such bodies to make up the present size of the earth.

Our atom is any one taken indiscriminately out of the myriads which, as we have so often observed, are constantly, perhaps in equal proportion, generated through what is termed empty space, and its descent to the sun, and the changes it is made to undergo, are what we propose to describe. We will take its first position as being born near the outside of the system, beyond the orbit of Neptune. If it had come into being in the first division of the creative period, before motion originated, it might have remained unchanged and immobile for ages; but as we are reasoning on the present, the instant it exists it is made to revolve round the sun by his rotation, and at the same time it gravitates to him by the force of his attraction. When it began its descent to the sun, which was at the instant it existed, supposing it to have been three thousand million miles distant, the time required for it to reach its final resting place would depend upon the rapidity of its descent, and as falling motion constantly accelerates, its gravitation at the end would, no doubt, become very rapid, but what the degree of rapidity cannot be told. If, however, it fell on an average as fast to the sun as the earth moves on its orbit, or at the rate of eighteen miles every second, it would take about seven years in its descent; and if two miles in the same time, sixty-three years on the journey; and finally, if a mile in a second, which might be looked upon as very rapid gravitation, above a hundred years would pass away before it became part of the sun. We cannot of course tell at what rate new creation gravitates; the comparison is therefore drawn that a vague idea may be had of the length of time aerolitic formations may exist until they are finally absorbed, whether it may be into the sun or the planets; and taking such a view of the question, there would be no irrationality in the conclusion, that matter from the outside of the system might take a century in falling the total distance to the great centre.

The velocity of meteors may be to some extent a guide upon the subject, at least as to the greatly accelerated falling motion in our position so near the sun. Any aerolite, for instance, which comes in to us had perhaps for many years previous its falling motion towards the sun, into which body it would undoubtedly have lighted; but in its descent it strikes into the terrestrial sphere of attraction, which at once turns it in a new direction to our globe. Its motion is deflected; but we suppose its gravitating rate is unchanged, and this of course leads it down upon the earth with meteoric speed, and the first notice we have of its approach is when it strikes into the atmosphere, having its materials scattered broadcast along the full length of its fiery track. The velocity of its motion, therefore, during the short time it is visible, if its rapidity is really connected with its previous solar gravitation, may give us some idea as to what rate the aerolite, in the latter part of its course, descends, and in a very limited and vague degree enlighten us as to the length of time these small collections of matter are, by their gravitation, in reaching the sun, as calculated from any particular distance their first atoms have originated.

Having thus far broken the subject, by dwelling on what we can know little of, the probable time it would take an atom to gravitate from any particular latitude of the system to the sun, we may again revert to the atom when it had just sprung from the womb of creation. In the first place, we are perfectly aware that the true literal meaning of atoms is that they are the smallest particles, and such examples as the finest grains of flour set afloat, or the motes in a sunbeam, fairly represent what are popularly looked upon as atoms. When applied to matter in its gross state, subdivided into the smallest possible parts, the meaning is correct. The principle, however, applied to things created, whether it may be matter animate or inanimate, in its dead or living state, means a building up of the structures from matter in the true creative atomic state, in its primal condition so attenuated that the imagination cannot descend to anything in it that is gross. As it ushers into being, it is, so to speak, as purely spiritual as the Being who creates it; and it being the material which makes up and nourishes all bodies, it must be imbibed in the same state, or otherwise, instead of creating it would destroy. Take animal and vegetable life, and we know they constantly imbibe an inflow of a mysterious something we cannot see, but to which we give the scientific term atoms; yet if atoms entered into their systems that had anything gross which the imagination could conceive, instead of drawing from them increase and nourishment, they would perish by their absorption. We suppose the formation of bodies of dead matter from primal creation is much the same. The matter, before condensing, is in the true sense invisible, not in separate grains so small that they cannot be seen even by the microscope, but in some kind of a diffused presence, just such a condition as the evaporated water so plentiful surrounding us, which it is impossible to feel or see. How it originates is beyond human conception; yet it still originates, and it has constantly originated since the beginning, and the instant it exists, although in a fluid or ethereal state, it is subject to attraction. It thus at once begins to gravitate, and whether in the literal sense the term atom strictly applies, the whole from the first is just acted upon the same as if all consisted separately of real atoms, or rather particles, whether of microscopic size or otherwise.

As the term atom in its literal sense will harmonise with the reasoning, the instant it existed, it by the attraction of the sun gravitated, and by his rotation it revolved—the two forces at the same time giving it a motion round the sun, and a downward motion to him. For, whether it be an atom or a world, all material objects or bodies revolve, if within the precincts of a governing body which rotates, and however small or large they may be, all are subject, under the same ruling body, to perform this motion according to distance, at exactly the same rate. Our atom, therefore, began its revolutionary and gravitating motions at once, and at the same time countless myriads of other atoms are in like manner revolving and descending to the sun, all—at least when condensed into something gross—going on their own orbits; and as such figures vary in eccentricity, and the motions upon them are at different degrees of velocity, and all in one uniform direction in obedience to the sun's rotation, our favourite atom either overtakes or is overtaken by other atoms at the intersecting points, until it like the drop of rain becomes condensed by combination into a particle. These latter are themselves millions in number,—in fact, the atoms we are accustomed to think of,—and the same movements lead them to combine in turn with each other, till at last what was an atom at the outside of the system, gradually gathers strength in its headlong winding course to the sun, and at some distance, be it more or less, becomes enlarged to an aerolite. It still descends, liable to increase from the same causes at every step, until it is finally incorporated and becomes for ever part of the sun. Beginning as an atom, it both gravitated and revolved through the long distance in a period of time which could not be less than years, and, taking an extreme view of the case, centuries may pass during its descent: all depending on the rapidity that gravitating or falling motion is capable of attaining; for, unlike all other motions, it, at least to a certain extent, becomes constantly accelerated.

Such we presume is something like the career of every aerolite which descends either on the sun or planets, and they are for ever coming down in millions upon the latter, and hundreds of millions on the former. They undoubtedly have done so ever since the sun was formed, and not only those aerolites, which from their magnitude make themselves visible when they touch our atmosphere, but likewise all other collections of new creation in a lower degree, down to atoms. These latter unquestionably also come in unseen and unknown continually; they are too small to leave tracks of fire, and at the first touch on our highest atmosphere they are instantly dissolved into their primal fluidity, and for the most part become part of the ocean. The ocean is thus converted into a universal agent in the production of new formations, which are constantly making the earth larger.

The matter which forms the aerolites continually originates no doubt through the length and breadth, height and depth, of the sphere of the system, perhaps in equal proportion; and we suppose the same creation has been going on without ceasing from the instant that the fiat of the Almighty caused by some unknown natural law the first atoms to float over the dark abyss. There were then no attractive centres, therefore matter was permitted to increase in its inert state during the millions of years that our space was part of the Milky Way; but when attractive centres sprung up and the formation of suns thus took place, the ancient luminosity was in time cleared away, planets out of a state of chaos followed, and systems eventually became organised.

Creation still goes on as from the first, with this difference, that the instant matter exists it begins to gravitate to one or other of the suns under which it originates, descending as the drops of a shower from all points of the sphere of each system respectively to the sun in its centre, except what may be intercepted by the secondary attractive spheres. Reasoning analogically, such has been the general condition of all the primary systems since they were reduced into a perfectly organised state, and our own system is in the same state. The sun rests near the centre with absolute power—his attraction predominating for thousands of millions of miles to every point of the sphere, and over this expanse all matter, as it originates in the atomic state, gravitates to him, and as it comes nearer, it at the same time revolves round him, and, excepting planetoids, all would become a part of himself were it not that the attractive spheres of the planets intercept the drops of the shower, according as they are of wide or narrow expanse. . If we therefore knew the true measures of their attractive spheres, we could tell what proportion falls on the planets, collectively, and what on the sun. There is a certain plane, or rather belt, in the system, its centre coinciding with the equatorial plane of the sun, and all the primary planets lie on this belt, leaning by their motions more or less on each side of the said equatorial plane, all surrounded with their attractive spheres, narrow or expanded according to their magnitude and distance. The system thus viewed, it will be seen that it is only on this planetic belt that any portion of the great and everlasting shower of new creation is intercepted from falling to the sun, and that over the two great hemispheres of space, right and left,—there being throughout these expanses no attractive spheres for the interception of matter,—all from these grand divisions fall to the sun, except the proportion which becomes enlarged into planetoids; in addition he receives all the aerolites which descend from the planetic belt referred to not covered with the secondary attractive spheres.

The total breadth of the attractive spheres of the planets added together, compared with the entire sphere of the system, if such an item of knowledge were possible, would enable us to judge what proportion out of the whole aerolitic matter falls to the planets, and how great may be the share that comes into the sun. The planets, taken altogether, are no more than a five-hundredth part of the sun in magnitude, so that their proper share would be the same proportion of the falling or gravitating matter; but what actual proportion they do receive could only be arrived at by an exact knowledge—making a small allowance for their distances—of the expanses of their attractive spheres, an item of knowledge which must always be in the highest degree vague. As regards the earth, we know by the lunar orbit that its sphere of attraction can be of no less expanse than half a million miles, and this enables us to guess somewhat near to its true diameter. It cannot be less than half a million miles, as just observed; and on the other hand, considering that the earth is in so near proximity to a body a million times larger, we may reasonably conclude that its predominant attraction stretches out to no great distance farther. If we put down the total diameter at three quarters of a million miles, every circumstance considered, the conclusion would not be wide of the truth.

Now, as the sun is at least a million times larger than the earth, the proper share of falling matter coming into the latter, including planetoids, would only be a millionth part of what nature continues to originate for the enlargement of both. To arrive, therefore, at the comparison of what proportion of creation the earth actually receives, if we divide the three-quarter million miles of space we suppose it rules over by its predominant attraction, into the total expanse round the whole sphere at that distance from the sun, the quotient will inform us that our planet is gaining in a great degree upon its great parent, by the share it receives from aerolitic and atomic matter alone, quite independent of rare increments, which in the nature of things it must receive from the fall of planetoids, small bodies which the sun's attraction cannot draw in. There are no other attractive spheres we can guess the dimensions of so near as this one; but if their true measurements could be made known and calculated, it would most likely be found that the total aggregate of increase of gravitating matter they collectively receive very much exceeds the five-hundredth part of the whole, and what is bestowed on them extra above that proportion, they continue to gain in the same degree in comparative magnitude to the sun. They are thus gaining on their great parent by the fall of aerolites and atoms alone; but there is another important increment which totally goes to their enlargement besides, namely, all the aerolites which are fortuitously increased into planetoids in their descent to the sun, none of which the latter can ever receive. The proportion of matter which thus becomes ephemerally independent is by no means insignificant, when compared to the total share of new created matter which comes into them.

That we may have a clearer idea of the formation of one of these planetoids—the lowest class of non-gravitating bodies, to which the planets collectively, since the system became organised, owe at least half their gradual increase—we will take another atom, beginning its descent to the sun somewhere beyond the orbit of Neptune. At the instant this atom is launched into being, it was acted upon, and had much the same relations as the former atom. It soon became a particle—on the same principles that condense the drop of rain—by the motions of kindred atoms joining it, and in like manner it increased from the particle up to the aerolite by other particles through their revolving motions. It was the fortune of this particular aerolite, as it thus gathered strength in its descent to the sun, to increase in a much greater degree than aerolites in general by a fortuitous combination with others in succession, until at last, as a collection of matter taken as a whole, it had an attraction within it as a body stronger than that of the sun reaching it in the position it was in. In other words, at some distance from the sun, be it less or more, it became large enough to be a centre of attraction, and thus an independent world, with all the attributes of other planets belonging to it. The sun ceases to have power to draw it nearer, so it loses one of its two motions, gravitation; but it retains the other, its revolving motion; and in the future, so long as it keeps free from planetary toils, it continues at a certain mean distance on an orbit natural to it as a body. Its degree of magnitude, at the instant of gaining its independence, rests on the position or distance from the sun it is in, for aerolites are liable to be increased into planetoids in any portion of the system, near or remote. Let the aerolite be fortuitously enlarged, wherever it may be, so that its inherent attraction is stronger than the attraction reaching it from without, so far as gravitating tendency is concerned, it is in a secondary condition absolutely independent; and, in regard to its magnitude, as the solar attraction decreases according to distance, the farther from the sun its position, it is in the same degree smaller. If it assumed independence as far out as the orbit of Neptune, where the attraction of the sun must be feeble figuratively speaking, in that latitude it would be a mere handful of matter and still be a planetoid, whereas at the distance from the sun we are in, where his attraction may perhaps be a hundred times stronger, the quantity of matter to be a planetoid must be in the same degree larger. Whatever may be the minimum size of a planetoid in any given latitude, is, of course, beyond what we can determine. This much is certain, that there is not an aerolite, in its downward journey to the sun, but has a remote chance of being increased during its descent to a planetoid; yet not one in hundreds, perhaps thousands of millions, ever rises to such a level. Viewing the question in any light, such formations must be extremely rare; but from the natural operations at work they cannot but take place, after which they or the matter they are composed of can never be drawn nearer the sun. As a body, unlike all his planets, he is wholly made up of aerolites and smaller morsels of matter down to atoms, which by the pulling force of his attraction only is drawn into himself from every point of the system. But if it so happens that the falling matter, through its revolving motion, accumulates together in sufficient quantity to be an attractive centre in itself, it instantly ceases to fall, being no longer heavy. It thus proudly remains up in suspense without requiring support, at whatever distance from the sun it may be, like any other independent planet.

When the fluid matter in our system centred in the sun, and by the same operations planetoids were formed in such vast abundance, a few of them, according to the then condition of things —nature gradually working order out of confusion—necessarily remained permanent and have thus continued ever since. They have therefore gradually gathered matter into themselves through all the creative period since the sun was formed, until they at last increased to the existing magnitudes and the perfect formation of our eight primaries. There would be many more primaries than the small number eight, but there is want of room—if there were sufficient room the bodies would undoubtedly be there, but smaller in the same degree as they would be numerous. Bodies ephemerally independent, or what we term planetoids or asteroids, have been formed by millions in all ages of creation; but for any one to be permanent it must have the whole course of its orbit entirely free from the orbit of any one of the primaries, and not only so, but at all points clear from the tracks of space their spheres of attraction pass round. When so related that the orbits of any two intersect or touch near each other, if leaning not much from the same plane,—and nearly all bodies so far matured as to be of perfect mould are so related,—the inevitable result must be, some time or other, that they will overtake at points sufficiently near each other, when the smaller of the two, if below a near equality of magnitude, will become, if not a part, at least linked in some form or other to the larger. These changes must have been frequent during the chaotic epoch, but, excepting the asteroidal zone, they are all on a large scale past, within our system. Collisions betwixt any of our eight primaries are impossible, for they are so related and wide apart, that they or their attractive spheres can never touch each other; but, we repeat, if the nature of the subject in its many bearings is properly studied, it can be proved, on the soundest principles, that there is no room in the intervals for any other worlds to be permanently independent. It is for this reason that not one of the millions of planetoids have been spared to continue as planets, except the small number eight, in their respective positions. Once raised to such a level, they are governed by the sun in every respect the same as the primaries; but unfortunately for their permanency they cross each other's paths, and their orbits while they exist being in nearly all cases of great eccentricity, they must either cut the orbits of the parent planets, or what is equivalent, they touch upon the belts of space their spheres of attraction pass round, and thus, whenever their motions lead them to or near the crossing points, when the great planets happen at the time to be at these positions, it is their common fate to be incorporated with them. If any one of the planetoids described an orbit entirely free from being at any points near any one of the orbits of the latter, it would undoubtedly remain independent—it was under precisely the same circumstances all the primaries rose—and like the other primaries, slowly grow bigger, as a permanent member of the system. That there is no room for such a body or bodies—for they are constantly coming into existence, but only eventually to add so much to the magnitude of the primaries—may be further explained as follows:—

If new-formed bodies described orbits nearly circular, or such as are described by the primaries, there would undoubtedly be room for additional permanent planets, at least in the intervals betwixt the minor planets; but it is well known that small bodies, such as the asteroids, have some of their orbits very eccentric, so much so that if they revolved betwixt Mars and the earth, or betwixt the latter and Venus—and the same applies to the major planets, for they are, on the average, actually as near each other in proportion to their more expanded orbits as the minor planets—there would be no room for their eccentric movements clear of the orbits of these ancient planets; consequently they could not remain independent longer than they would be entangled in their attractive spheres, at or near the intersecting points. Again, bodies of smaller magnitude than the asteroid have their orbits still more eccentric, if the rule holds good that such figures are more or less eccentric in conformity to the shapes of the bodies which describe them.

Thus old bodies, with the exception that they fall off somewhat in the directions of the poles—declensions always more or less according to the rapidity of their axial motions—are all, as far as we know, perfectly round in shape—so far as their rotatory rates of motion will admit—by having received through the course of ages, on so extended an average, an equal quantity of matter from without over all their surfaces. Their orbits, therefore, are in the same degree circular as they are round in shape, but the case is entirely different with new-formed planetoids. They are of any chance shape—even asteroids in a less degree must be so—whereas, the more matured a body becomes, it is in the same degree developed nearer to the perfect shape, according to its rate of rotation, until it finally attains perfection of symmetry. Our own planet has attained perfection in form, and most likely the other primaries and some of their moons. Hence, their orbits are all circular as their bodies themselves are spherical. If they had not this falling off in the polar direction common to them all, more or less according to their respective rotatory motions, they would be perfect spheres, and move on orbits which would be true circles. Were all orbits therefore circles, and had been so from the first, there would be room for a much greater number of permanent planets within the system, as the intervals between the existing orbits prove; and what is more, they would actually exist, for they could not intersect each other, so as to come too near and be mutually incorporated. But, as no orbits we know of are true circles, and as all new-formed bodies are of necessity irregular in shape, their orbits must be in an equal degree eccentric as they differ in shape from the sphere.

Why, it may be asked, is a new-formed body irregular in shape, and an ancient planet have the most perfect form natural to it as a rotating body? The perfection of the great planets in shape is very easily accounted for when their magnitudes are considered, and the immense periods of time in their gradual increase, for that long period drawing from all points about an equal quantity to all parts of their surfaces. In their primal steps of independent existence, when planetoids, they were of any shape, just according as their materials came together through their revolving motions. Immediately after, they were in their first advancing steps of magnitude—becoming enlarged by little worlds gradually coming in to them through their revolving motions—of various sizes, but generally small, and such as would not sensibly alter the figures of any of the primaries at present. It was of course during the chaotic period these operations continued, and until the last of these primal formations were incorporated, they may have had rough outlines of rotundity; but it was only in the ages which were to follow that they could attain the perfection of form. When chaos was collected in, there remained no more primal worlds to be incorporated, the system was organised in its existing settled condition; with this difference, that we suppose the secondary bodies were vastly smaller, and in the time following gradually rose to greater magnitude, just as at present, by the fall of invisible matter, aerolites, and lowly planetoids. In the present settled condition of things, the latter class of bodies, although many of them remain long independent, seldom increase to a great degree higher, and from their smallness have no effect when incorporated in disfiguring the shapes of any of the planets. It is very likely that two or three such visitors fall upon our earth during a century, and the approach of any one of them in reality is only as an enormous aerolite, and like the latter, at the first brush on the atmosphere, it is, with the exception of the discharged meteorites, dissolved into invisibility. These, the largest modern bodies which become incorporated with the planets, can therefore have no effect in altering their shapes, or rather, if misshapen, they would by so much impart to them more perfect forms. The same may also be said of all other matter which descends upon the planets, from the invisible up to what become visible aerolites. They come down as drops of a shower, equally over all their surfaces, so that the older the planets are, by these increments they have reached their perfection of shape during a time proportionately long. These operations demonstrate the causes both of their roundness, and their rhomboid shapes; but without atmospheres they could never have attained polished symmetry of form. Atmosphere means oceans, for without it no water could exist, which, as we have shown elsewhere, are the true receptacles of new created matter on any body, and these hollow places on the surfaces of globes through all ages getting constantly filled up, it is impossible, except they may be of malformation, that any one of the primary planets, if covered with atmosphere, can be any other than of the most perfect symmetry. So much for the perfection of shape, which we believe that most, if not all the planets, have long attained; but it now remains to be shown that they as well as all secondary bodies have begun and do begin of any arbitrary shapes, just according as their materials at the first may have chanced to accumulate together.

From the sun down, as has been so frequently repeated, they have begun and do begin as atoms, and the instant the atom exits, its revolving and falling motions together quickly lead it to combine with other gravitating atoms into a particle, but without any common bond of union. They simply lie side by side, and from the same operations the accumulation goes on increasing until it rises to the status of an aerolite—or rather an object large enough to be visible, when by its gravitation it strikes the atmosphere—but still without the slightest bond to hold its condensed atoms together. They are all brought simply by their revolving motions into juxtaposition, but each atom of the collection—for want of the central bond of union—as independent of the others as if they were thousands of miles apart; yet, when their motions thus bring them together, there is in their close contiguity no existing force which can separate them. They are just a collection of atoms brought together by revolving motion in the manner described, and as such, although without a common bond, must move safe from dissolving asunder on a common orbit through space, in which there can be no opposition, and being all at an equal distance from the sun their rate of motion in any direction must be the same. The materials of aerolites therefore when once together cannot by any forces acting upon them be dissolved, and we take for granted that this aerolite in particular, much more so than millions of its fellows, during the long years of its descent to the sun, frequently overtook or was overtaken by other aerolites, or matter in a lower degree of combination, till at last its materials collectively had an attraction common to the whole stronger than the attraction of the sun upon them, in the position of the system they happened to be when the change took place. That instant attraction turns from all points of the unconnected congeries of atoms and centres to its heart—figuratively speaking, it inhales life; and the whole, instead of becoming food for the sun, is tied together by bonds however feeble, and instead of gravitating, it is thus enabled to keep its distance as an independent body, revolving in the future on an orbit in the same degree eccentric as its fortuitous formation and its newly compressed shape may differ from a perfect sphere.

All worlds, whether destined to remain permanent or to be swallowed up in the embraces of others, are thus begun, and at this, their first step to independence, is their primal configuration, which is just the shape their atomic matter happens at the eventful crisis to be. It is a chance make-up of materials, brought together by revolving motion, without the least regard to rotundity, and whatever figure the aerolite had, it still retains when invested with internal power to compress itself in. It simply collapses together, and as the balance of attraction as opposed to that of the sun is only at the turning point, the pressure towards its own centre is infinitesimal; but still the principle is the same, and it is with this shape it first assumes that it begins to revolve round the sun on an orbit not differing widely in shape—that is, if there is a general law, subject to which all orbits agree in figure to the shapes of the bodies which describe them. But, whether or not such an idea is based on truth, the aerolite, when once exalted up to the status of a planetoid, is constantly liable to be increased, and as we take it not to be one of the vast majority liable to be incorporated, let us trace up its earliest development from its primal state. As time goes on it increases a little, be it more or less, by aerolites, and perhaps other planetoids uniting with it—but in the present state of the system, the mutual incorporation of planetoids must be very rare—and every such addition has a tendency to improve it from its first chance shape somewhat more to the globular; but it would have to increase through a long series of ages by receiving into itself millions of aerolites, down to atoms, and a proportion of planetoids—a system of early growth all the primaries have passed through—before it would attain the perfect figure natural to it as a rotating body.

Should it be a body without rotation, if there are any such, its perfection of figure would be a sphere, but if like perhaps all other bodies it turned on an axis, it would be equally perfect in form—its equatorial line being a circle, with a falling to both its poles according to the rate of its rotation. The operations at work all tend, the older bodies are, to thus mould them to perfection as described—a perfection the earth has long attained, and most likely the other seven primaries, together with some of their largest moons, if they are sufficiently warmed with atmospheres. Letting this idea, however, pass, it is most likely that no bodies excepting new-formed suns can ever assume the perfect form before attaining a magnitude larger than any of the asteroids—as an applied general principle Juno may be an exception—and such a degree of magnitude, as to rank with the lowest of these asteroids, we suppose, has perhaps never been attained by any planetoid since the system became organised as it is, much more to be increased to a magnitude that would be of perfect mould. Embryo worlds must then run on orbits eccentric in the same degree as they are of imperfect figure, and thus their wayward courses account for none of them being spared as planets. If they as infant worlds had but the equatorial roundness, then their orbits generally would be as circular as those of the old planets, and thus a few of them might find room and be permanent. This can never be, as irregularity of shape must belong to all small bodies, and as these irregularites belonged to all the primaries in the chaotic periods, and in a gradually lessening degree for long after, the irresistible conclusion must be, that it is impossible any greater number could have had permanent existence within our system than the eight planets. With the great intervals between their orbits,* at first sight the conclusion is improbable, but a careful study of the operations at work enables us to arrive at the clearest evidence, based on irrefragible principles, that there would have been millions of primary planets, such as they might be, in our system, if there were only room for the number. It is the eccentricity of new-formed bodies which accounts for the planets being so few. They must move clear of each other to be permanent, and out of the hundreds of millions of worldlings formed during the past, only eight, exclusive of their moons, have been able to retain the proud distinction of permanency. Another wonderful proof vouchsafed to us of Almighty design ! If every planetoid was permitted to continue for ever, the whole of secondary creation would be made up of these minute invisible objects as worlds, inclined up, more or less by the rotation of the sun, to the planetic plane, sprinkled thick as rain drops, and altogether useless for the purposes matter was created.

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* It is a curious but natural fact, which corroborates all our ideas, that as we go out in the system, the intervals betwixt the planets increase at much about the same rate as their orbits expand. Viewed in this light the major planets are relatively as near each other as the minor planets.

A very pertinent question might be asked, How do we know of the existence of the planetoids ; for no such body was ever yet seen ? They are not seen, because they are too small. If at a reasonable distance they might be visible, but not one of them in their annual rounds can ever be much nearer than half a million miles distant, except when caught within our attractive sphere, in which case it soon descends and is spread abroad by the opposing medium the air, coming in as a huge aerolite. At this nearest possible distance, the most perfect telescope is powerless to bring such small objects to view ; but to conclude that they do not exist, with the evidence we see around us, would be as irrational as to hold that only visible worlds have a being. We would be perfectly ignorant of the existence of aerolites only for their lurid tracks, yet they, not including the smaller unseen, come into the earth in about a million daily. And what are they ? Simply planetoids not full grown. Every one of them is in reality the beginning of a world in itself ; but it is their fate nearly all to descend—principally upon the sun—before they become enlarged to independence. Not one aerolite out of hundreds of millions ever rise to such a status ; but yet so frequent that we have no more doubt than if we could behold them, that, as the next creative step above aerolites, they are more or less common as hosts of unseen worldlings throughout the system, except the remotest outskirts and a comparative narrow expanse immediately surrounding the sun.

In the more distant part of the system, from Jupiter to Uranus, we suppose them to be vastly numerous, but when we pass on from Mars to the sun, within this space they probably form in much lower proportionate number. Running, as such primal bodies generally do, on very eccentric orbits, many of them at their perihelions may be in these low latitudes, while their mean distance is much wider ; because, when a collection of atoms continues an aerolite till it passes the orbit of Mars, the sun's attraction is so strong, and by this time its constantly accelerated gravitation so rapid, that its combination with other aerolites into a planetoid becomes

ıncertain. Still, when we study the natural operations which
them, there must be planetoids in relation to the earth,
ıgh very few compared to the mid-regions of the system, and
ir perihelions some may even touch as near to the sun as the
of Venus. Every circumstance considered, however, we may
upon planetoidal formations among the minor planets as
few, and it is for the most part at their perihelions they
within reach of the earth; but it is likely none of them
so low as the latitude of Mercury,* and on account of the
rown magnitude of the sun, rarely or never at Venus. Again,
the earth and Mars may be sometimes added to by plane-
we may reasonably infer that all the minor planets owe the
r part of their bulk to what the sun is totally made up of—
nstant fall of aerolites, from the lowest which are invisible
the highest.

ending to the three major planets nearest us, we conceive it
over that space that nearly all planetoidal formations take
In short, we look upon the eight planets, although formed
ling to the order of their positions at times wide apart, but at
ıen they were all constructed as at present, the superior ones
s gained upon the inferior by the advantages their positions
them of being enlarged by most all planetoidal formations
the system, plus the aerolites which fall upon them in
on with the others. As to the inferior or rather minor
s, it is possible they were made up to their present magni-
from the time the primal planetoids were gathered in, almost
by aerolites.

wing the subject in relation to the major planets, there is

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ercury, the same as other planets, undoubtedly increased from a
id, but the sun was then small. For a planetoid to exist so near the
present, on account of the power of his attraction in so close proximity,
d have to be comparatively a large body, perhaps visible through the
e from the earth. There is, therefore, some reason for the conclusion,
ne of these lowest independent bodies move so near the sun. Besides,
ng the idea of the nearness of position, the natural operations at work,
e system became organised, could never at any time have collected new
matter into bodies large enough to be planetoids so near the sun. It
ble the movements of new-formed planetoids sometimes lead them into
se proximity; but when brought so near they are reduced back to the
on of the aerolite, and of course drop into the sun. In other words, an
may increase to a planetoid at some point on the other side of Mars;
independent, the eccentricity of the orbit natural to it may be such that
helion would be as near to the sun as Venus, or even Mercury. It
therefore, that although in its first position it gained independence, it
gain be an aerolite, after reaching in its first annual round near enough
solar attraction to be sufficiently strong for the purpose. There is little
early at the first, when the sun was by comparison very small, in that
gree of latitude where Mercury exists, planetoids were more or less
us, or it would not be there as a planet, and the same applies to Venus
gher degree; but rising up to our own latitude, planetoids for various
must still exist, yet on account of the eccentricity of their orbits they
tually in the mean be at double the distance from the sun as that of the

reason to believe that the three nearest of these bodies owe very much of their enormous magnitudes to planetoids, generally of a size which in our latitude would be aerolites; and in addition, they had another immense advantage over the minor planets, in their wide spheres of attraction. No doubt, the planets nearer the sun lie in that part of the system wherein the shower of matter becomes more concentrated, and in the same degree, according to the expanses of the attractive spheres, falls thicker. But, when we consider the widening of the attractive spheres in the much greater distance, these great bodies which we suppose began much upon the same footing as the earth and the other minor planets, from this source alone possessed overwhelming advantages, by intercepting with such wide expanses of predominant attraction new creation in its descent to the sun.

In whatever light we judge the question in relation to our abnormally expanded system, the huge magnitude of these planets is principally due to their largely extended spheres of rule, which captivate falling matter equally wide, but more especially the two nearest of them, Jupiter and Saturn. They lie in the particular latitudes of the system wherein planetoidal formations in the greatest abundance naturally take place, and which, wherever they are formed, in time become part of the planets whose orbits at any points they trespass over. Shifting, in the next place, from the major planets nearest the sun to Neptune,—which, there is strong reason for believing, is the outside primary of the system,* —the same reasoning applies, in one sense, in a still higher degree. His sphere of attraction, considering the feeble power of the sun at such a distance, must be enormous, and if he is, what we firmly believe, the remotest of our planets, properly speaking the expanse over which his attraction prevails, on some parts of his course, is not of rhomboidal outline like the attractive spheres of the other planets, but somewhat irregular, because of his system at certain points of his circular course brushing upon the outskirts of the nearest solar systems, while on some other positions of its orbit it might be one or two thousand million miles short of such limits, all depending on the irregularities of the borders of our own system.

We have more than once observed that the expanse of Neptune's attractive sphere may be as much as half a thousand million miles in diameter; but whatever it is, lying as we suppose in the remotest line of latitude, it is improbable that planetoids—although they must be very small where the sun's attraction is so weak—have time to be formed to any great extent on most positions of the circular belt of space its attractive sphere sweeps round. If such is the case, as a primary, it gains little in magnitude from planetoidal formations, and like the sun, during the course of time, has drawn in a large portion of his matter by the direct force of attraction. This has not always been so. At the beginning of the chaotic period in that remote position, when the mist was being cleared away by its gravitation to the sun,—just at the distance where the solar attraction was at that time dying out to nothing,—planetoids from the bulk of a man's hand down to particles must have been in vast numbers, thickly sprinkled over the expanse. The attraction was there infinitesimal, at the time next to nothing, and the size of the planetoids on the same scale numerous as they were small, and from their collection together by their orbital motions, Neptune was begun as a body the same as the other planets. But over these remotest regions of the system the attraction from the sun has since then become—although still very feeble—as much stronger as he has increased in magnitude, while the farther extension of his rule is bound in by the border lines of other systems that we suppose lie comparatively near. Whatever, therefore, may have been the condition of matter at that early period when the solar attraction in the latitude of Neptune was all but nothing, now when it is stronger in the same degree as his magnitude has since then increased, we cannot see that planetoids to any great extent can possibly be formed in this remotest division of the system. New created matter in the atomic state, in its fall from the outskirts of the system, must have a longer descent on its way to the sun before it has time by revolving motion to increase together large enough to be planetoids. Taking these various considerations into account, we may reasonably infer that this outside primary of the system has been to some extent made up of matter which nature originated within the precincts of his attraction, that, if his sphere of rule is as wide as we suppose, would account for a certain fractional part of his bulk, in addition to the falling matter he in common with all the other planets intercepts.

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* If there is another primary more remote, from the progressive widening distance which must exist between all the planets, in proportion as the area extends, it cannot be greatly short of two thousand million miles farther out. When we therefore consider the nature of the operations at work, and broadly study the machinery of the system as a whole, we think it might be conceded, as at least very probable, that there is no other primary planet subject to our sun beyond the orbit of Neptune.

It is for want of time in its descent to the sun for the atomic matter to accumulate sufficiently together, that we suppose is the cause of few planetoids being formed as far out as Neptune; but when we approach a thousand million miles nearer the sun, touching the belt of the system swept round by the attractive sphere of Uranus, we are at a distance from the outside, where we might expect planetoidal formation to fairly set in. For it is likely, that at least there is a distance from that planet to the borders of the sun's dominion of two thousand million miles, and in the fall of atoms so far, they have time in some instances to increase by combination large enough for the purpose. And that we may have a vague idea of how the two remotest planets are made up, let us suppose the attractive sphere of Neptune to be six hundred thousand miles, and that of Uranus one-fourth of the same diameter. These suppositions are no doubt widely erroneous, for they are founded upon no data; but if they were correct—and there must be some comparisons of expanse in their attractive spheres—the one attractive sphere would be of sixteen times greater surface in disc measurement than the other. At first sight, it might thus appear that Neptune receives sixteen times greater quantity of gravitating matter than Uranus; but a moment's study will satisfy that this cannot be. In the first place, Uranus is so much nearer the sun that the creative shower of matter is greatly concentrated; or in other words, according to the expanse of its attractive sphere, Uranus receives—including the proportion of new creation which originates in the wide interval betwixt the two planets—perhaps double the quantity of gravitating matter, according to the expanse of its attractive sphere, thus reducing the proportion to an eighth compared to what falls into Neptune. If both bodies, therefore,—on the basis of all the foregoing facts being correct,—had from the beginning been wholly made up of gravitating matter, or rather aerolites, we should expect Neptune to be eight times larger than Uranus, but as near as can be ascertained it is only three times the size. This lower difference in their respective magnitudes, caused by the much greater proportion of planetoids which Uranus receives, is just about what we might naturally look for from the position nearer the sun which it holds. The supposed proportion would not be very far from the truth, if the relative expanses of their attractive spheres were as here given, but as we are of necessity reasoning from unknown quantities, the calculations must be all erroneous; yet, whatever is the proportion, be it more or less, the difference to the planet Uranus must, during the lapse of time, have been made up from planetoidal formations, for it must always be kept in mind that the enlargement any of the primaries receive from planetoids, is just that much additional increase beyond their natural growth from the fall of aerolites.

The next step in the system sunward is Saturn, with his annular appendages and moons, which, taken altogether, give the most wonderful testimony of any other feature in the heavens on a large scale, except the asteroidal zone, in favour of all we have advanced on the subject of planetoids. The rings themselves, let us once more repeat, are neither more nor less than the consolidated debris of overgrown planetoids, raised as favoured secondary centres to the magnitude of huge worlds, before they were caught and their materials spread out by their collisions into the majestic rings we so much admire; and the seven moons in like manner became in a lower degree enlarged before they were reduced to secondary subjection. The bodies out of which the rings were formed fell upon the planet because of the rapidity of their axial motions, or they also would have been spared as moons, while the seven little worlds which are moons were saved from a worse fate by having slower rotations severally than the planet, and are thus preserved in a lunar state instead of having been incorporated. But having treated these subjects elsewhere, we may here observe, that in reaching Saturn we are within the region where planetoids begin to thicken. At this distance from the outside of the system, the falling atoms in coming down from such a depth in space have time by combination to increase innumerable into such formations, when, of course, having lost their gravity they can descend no nearer the sun than the eccentricity of their many orbits, natural to them severally, will permit. They therefore for a time, longer or shorter, revolve like other planets till they are by these movements—in such small bodies always very eccentric—eventually caught by one or other of the great planets they may trespass upon.

A very large proportion of the bulk of this planet must be made up by these bodies thus falling into its meshes, and still more so Jupiter. Saturn draws in from the natural source aerolites greatly in excess of Jupiter; because its attractive sphere is much wider, and to the same extent it intercepts the fall of matter. If it had been indebted to this source alone for its materials as a body it would perhaps now be no greater in magnitude than Uranus, while the total aerolitic matter which has fallen into Jupiter from the beginning, if abstracted from the body, would to look at not be sensibly diminished.

In short, if all the eight planets had come into existence simultaneously, and each one had continued to increase and grow out only from the fall of aerolites, the same as the sun, the natural result would be that the one nearest the sun would be what it actually is, the smallest, and the most distant the largest—each one, in succession, being larger than the other in their order of distance. The planet Venus, for instance, would be as much smaller than the earth as Mercury is to the former; but while there is a little difference in favour of the earth, it is much below the magnitude natural to its position. Again, the planet Mars should be at least four times as large as the earth, but it is in reality that much smaller; and in the next step, the asteroidal zone, if all the numerous bodies sprinkled over it were collected into one,—as we believe they will be at some time or other,—the whole united would form the smallest one of the nine planets, and perhaps be inferior to our moon in magnitude. Here, then, is the third step from Venus, a belt of the system at least a hundred million miles across, in which there is another still greater declension of matter. The causes of this gradual falling off of matter from Venus to Juno, we must for the present pass over by briefly observing that it is the influence of Jupiter which has robbed the earth, Mars, and the asteroidal belt, of very much of the matter which, in the absence of that great secondary, would naturally have belonged to these divisions of the system. Mercury and Venus differ naturally in magnitude, according to their positions, and they are so placed that the matter which legitimately belongs to them escapes, being caught in the toils of Jupiter, and in like manner, Uranus and Neptune, all which four bodies we presume are made up for the most part from the natural source—aerolites. They thus all gradually increase in magnitude as to their order of distance. Again, Saturn and Jupiter in a sunward direction would have, each as compared to the other, been smaller in succession, had they during the lapse of time grown and increased by gravitating matter, intercepted in its descent to the sun, the same as the others—they in their order would also be much smaller than the two exterior planets, Uranus and Neptune; but they are just in that latitude of the system wherein aerolites in their long descent to the sun increase in greatest number into planetoids, and we again repeat that it is from this source that these huge planets have been enabled, from the beginning, to appropriate to themselves nine-tenths of the matter which in the system is saved from the grasp of the sun.

These effects are produced in our system, by reason that it is like those of the other great suns enormously wide; but we suppose such a vast difference in the comparative magnitude of planets in the minor solar systems would be impossible. To elucidate the idea, let us take a system of one of the minor suns to be of as wide expanse as the orbit of Saturn. This would not exceed, measured spherically, a hundredth part of what we believe our solar system to be, and, like the same comparatively narrow area within it, to have six primaries of its own. If the planets and sun of this minor system would have about an equal proportionate quantity of matter, according to its extent, as that contained in our system, its sun would be about a hundredth part of the magnitude of our sun,—not a very contemptible body,—and the six primaries would in like manner have apportioned to them collectively also a hundredth part of the total quantity of matter which belongs to our eight planets, including the moons, rings, and asteroids. Even this small division, compared to what belongs to our primaries, according to our ideas, would at least raise some of the six to be abnormally large for habitation.

In the natural order of things, these six planets in their small system would be larger, according to their remoteness, if wholly built up from the common source of all planets and suns, aerolites. But planetoidal formations must be an important quantity in the make-up of planets, not only in this system we are considering, but in those of all others, except the smallest; and in relation to its six planets, instead of disturbing the balance, as in our own system, the planetoidal increase as bestowed preserves it. In our system, for instance, the expanse is so wide that aerolites in their years of descent to the sun, have some of them time to be increased into planetoids, when or before they reach the middle distance. In these mid-regions, therefore, the great majority—allowing for the eccentricity of their orbits—stop, so that, from this source, the two huge planets have been enabled to monopolise immensely beyond their natural share of planetary material, saved within the system from the absorbing power of the sun. On the other hand, we suppose, that in the little system we are reasoning upon a very unequal division of matter would be impossible. As a system, it is too narrow to give time for planetoids in any great proportion to form and rest in the middle distance, and judging by our own system, we are enabled to conclude, that they continue to form with greater frequency for the whole distance, until the sixth planet nearest the centre is reached. The inferior planets are thus enabled to make up, by the incorporation of planetoids, what they lack from the fall of aerolites, and by these operations there is a natural balance of magnitude bestowed upon all. The sixth or superior planet, being like our own Neptune the outside one, revolving with its wide attractive sphere round the remotest belt of the little system, practically is added nothing to by planetoids, but gains by the natural supply more abundantly than any of the others. The next towards the centre gains less from aerolites and a little from planetoids, and so on in succession, each one receiving more of the one and less of the other: thus there is a continuation of worlds within the same system, few, if any, so vastly exceeding the others as to be of uninhabitable magnitude.

By such reflections we are sublimely struck with the designing wisdom of Omnipotence. In little systems the proportion of matter spared by their suns being just about what, in the lapse of time, will make up their planets to magnitudes suitable for habitation, and thus nature provides a proportionate equal division; but in the few great systems of the universe, such as the one we are in, nature so works as to heap the superabundance on a certain number, and preserves a few as fit habitations for His creatures. Had the bulk of planetoidal formation settled upon our four minor planets, the same as we suppose is the case in the solar systems of more natural expanse, they would be enlarged above habitable size, and the same condition would be common to the remoter ones. They would all not differ greatly in magnitude, and thus, according to our ideas, they at least would have, because of their magnitude, been rendered very unfit—by reason of too strong attraction—to live upon. As it is, four out of our eight planets are preserved as places fit for intelligent beings.

The parallel drawn of the two suns and their respective systems—the one known and the other unknown—would only hold good if the rotatory rates of both were about equal. Time after time we have shown that the government of the universe rests upon rotation, and that it is to the same motion all secondary bodies owe their existence, and without it no other bodies but suns could have had a being. If nature had bestowed no rotation upon the sun, his attraction would have simply drawn in all matter within the reach of his power in its unchanged fluid atomic state, in straight lines into himself, and thus the whole expanse over which he is predominant would have been a blank. As it is his axial motion is very slow, and this, his sluggish rotation, solves the mystery of such a vast preponderance in his bulk of matter, compared with all the other bodies of the system collectively. His slow rotation has enabled him to monopnearly the whole, but had this motion been twenty-five times more rapid, or the same as that of the earth, the planetoidal formations —which we suppose make up nine-tenths of the total bulk of the planets, taken altogether—would have been the same number of times greater, and there would have been even excess in equal degree, subject to any other rotatory rate still quicker. Thus, if the rotation of the sun had been as quick as that of Jupiter or Saturn, the planetoidal formations in all time past would have been at least sixty times more numerous; and allowing for the increase the planets collectively receive from aerolites, they would, subject to the government of such rapid rotation, be actually about fifty times larger than they are. It would only be the major planets, and not the minor, that would be so increased. In abnormally large systems, nature so works that a certain proportion of planets cannot be enlarged above habitable size. Such is the actual condition of our minor planets.

CHAPTER XXX.

STATE OF CREATION IN THE ASTEROIDAL ZONE.

Let us, in the last place, turn our attention to that remarkable division of the system we term the asteroidal zone, a belt wider than from here to the sun, and still labouring under the throes of the chaotic state. All the other divisions of the system, most likely, have been long brought into order; but here the ancient planetoids formed out of the mist still hold apart in hundreds, time having slowly increased many of them to magnitudes visible to the telescope. They are known to astronomers by the scientific term asteroids. We will not just now enquire why it is that ancient chaos has so long triumphed in this region—a state that was universal at one time or other throughout all the other divisions of the system; but it presents a wonderful monument of the past, and also proves that the chaotic epoch is not entirely at an end even yet within our system. These asteroids are already known in number about a hundred and seventy, beginning with Juno, a body which has already attained the status of lunar magnitude, down to others so small as to be barely visible to the telescope; but yet the smallest must be of some considerable size, as otherwise they at such a distance could not be discerned. No doubt many others are yet to be marked down on the celestial map as part of the group, and a still greater number will never be. Many unknown asteroids may be visible, but they are so mixed up with the telescopic dust—which astronomers are so fond of placing in space infinitely remote—that they are overlooked, and descending lower, there are others too small to be seen, and lowest of all there is an admixture of humble planetoids; but this latter class, we suppose, are not more numerous than in other parts of the system.

When we speak of such a great number of bodies being in the asteroidal belt beyond what human eyes have ever observed, we reason from analogical testimony equally as sound as that visible stars have subject planets. The operations which built up the sun and left behind, as remnants of the mist, millions of planetoids, revolving in all latitudes of the system, prove that as the same chaos still exists they must be here, the known and the unknown, we might venture to say in thousands. We do not include planetoids properly so called, but a class of very small bodies which, during long ages, have advanced from that lowest condition of independence all the steps higher up to those which are visible, and of these last there are likely a much greater number to be discovered than what are already made known. Each one of this host of little worlds goes round the sun with an independence as absolute as the major planets themselves, and they will thus continue so long as they are vouchsafed a separate existence. As before observed, the largest of them are visible to the telescope, and perhaps a much greater number yet undiscovered, while improved telescopes would reveal to view others in a lower grade and in the same degree more numerous, and thus descending still lower, the number increasing at each step, to the lowest order above planetoids.

The reason of such petty bodies existing innumerable in this region can only be accounted for on the principle that they were more unfavourably related, so as eventually to be all incorporated together into one body, than the primal planetoids in any other division of the system. We take the asteroids which we see as being as old, or rather older, than Jupiter himself. Planetoids in plenty were at the beginning left in all parts of the system to unite and in time become the nuclei of the planets. These asteroids, in this belt of the system, are actually the ancient planetoids—somewhat enlarged by time and mutual combination —still moving apart from each other, as when they were first formed out of the mist, instead of being as yet united together as one body. The true reason that thus far there is not a ninth primary, no single body—such as we have described the earth to have done—took a commanding lead so as to have swept into itself, during the ages which have since passed, all the others. With one exception nothing approaching a great leader has sprung up, into which all the others in time past might have become incorporated; consequently centres innumerable formed, which have increased almost *pari passu* with each other. Every one independent of the other seems only to have taken a little, each a small moiety, to itself. A great many have thus risen to asteroidal magnitude, and the result is, with but the one exception, that we have many little ones, and—although in some instances widely differing—they are generally of so near an equality that they cannot mutually combine; while the one, which is so much advanced above the others, and in this sense the natural leader, has never, so far, taken such a commanding influence in the time past as to have united them all in itself and thus be elevated to the status of a ninth primary.

The body referred to has, at least by magnitude, already gained so much over the others, that it would long since have swept the whole number into itself, were it not that it has an unfortunate leaning on its orbit, very much out of the planes many of the others lie upon. In their tracks round the sun they therefore escape being caught; such is one of the real causes why this part of the system is still in its primal chaotic condition. It is possible that combinations might take place betwixt the other asteroids, and a new leader through such operations spring up; but even that would fail, for the one referred to in itself is larger than all the others united. Besides, admitting the possibility, such a degree of equality has arisen betwixt the asteroids themselves,—except that they might hit straight on at some of the crossing points, occurrences not impossible, but so extremely rare that practically speaking it may be said they never happen,—it is extremely improbable that any other combination could take place, so as to raise a second sufficiently large as a leader with any reasonable chance of becoming the future primary.

To explain why it is that bodies of near equality never can incorporate except under the all but impossible circumstance of their motions leading them right on each other, we may observe that no attractive sphere is perilous to any smaller body until it is so far within it as to be under the governing control of the body in the centre, from whence the attraction proceeds. This it cannot be without there is considerable difference in the magnitude of the two bodies. As to the asteroids, we cannot know their true magnitude, but our knowledge concerning them is such that, generally speaking, their equality is so near that the meshes of their attractive spheres differ so little as to be in most cases inadequate to ensnare one another. Any one of them, for instance, to have an attractive sphere sufficiently wide to captivate another, must be a body at least ten times as large; but generally between the visible asteroids there can be no such difference. Hence combination, or rather mutual incorporation, can very seldom take place betwixt these small bodies. This we suppose is the second leading cause why this belt of space under the sun still continues unorganised, and in somewhat the same condition as the other divisions of the system were at one time or other. But the operations are in full work which will in time subdue chaos even here and collect all into one, yet from the adverse circumstances mentioned millions of years may intervene. The operations themselves that must reduce all to order consist of thousands of little worldlings seen and unseen, visible and invisible, in this belt of the system, from planetoids upwards, all winding round the sun in the one direction on orbits differing in inclination and eccentricity. They therefore cross each other at myriads of intersections, where they must frequently come upon each other; and although their near equality of magnitude generally prevents their mutual incorporation, the operations will in the end so modify their relations with each other as to blot out all their orbits and incorporate them together. These operations over a limited area are just what was the condition of the different divisions of the system in turn, but from many opposing causes this particular division is left behind in the race. The other eight planets are perfected so far as to have collected into themselves all that the attraction of the sun spared to them out of the mist, but these asteroids are the early planetoids still scattered wide, which will all in time be part of one body—a ninth queen in the system, which will fill up the only link of the chain that is wanting.

There is one of the asteroids named Juno, the uncrowned queen referred to. She has already risen to lunar magnitude, and is so much advanced as to be perhaps larger than all the others united, and she could only have reached this ascendancy by having incorporated a large proportion of them during the past. She thus proves that, if she cannot be ranked as one of the nine planets, she aspires to that exalted status; and by reason of the commanding relations she has assumed in connection with the other asteroids, we presume she is destined in the course of time to incorporate the whole number, known and unknown, and thus at last to take rank in the lowest step as one of the primaries. By a rare combination of circumstances some one of the other asteroids might become enlarged, and in a sense take the lead for a time by incorporating the others in a greater degree; but this planet—it really should be called a planet—is so much enlarged that it may be looked upon as impossible another leading body could arise. The influence Juno holds—if she can only keep clear of the clutches of Mars—will therefore progressively increase, and the end will be that the multitude of surrounding mimic worlds will all be a part of herself, but on account of the lean she has on her orbit the time must be very remote. It is not the magnitude of Juno which invests her with power over the others, but her attractive sphere, and according to its expansion her power to captivate them is in the same degree greater. The true expanse of her sphere of attraction we must of course be ignorant of, as we are without correct data to determine such questions; but it is wider in the same degree as she is larger than any of her fellow asteroids, and considering her magnitude and distance from the sun it cannot be put down at much less than from three to four hundred million miles in diameter. Such a narrow expanse is no doubt insignificant, compared to the extended belt of the system over which the asteroids revolve. We must, however, consider that Juno in a very eccentric course sweeps round the entire space—except the fractional part of twenty million miles trespassed within the orbit of Mars—once in about three years, and every planetoid or asteroid her sphere of attraction trips upon, be they few or many, are inevitably incorporated with her. This process goes on repeating itself during all her annual rounds, and she retraverses the same thread of space only so long as her body remains unchanged in shape. This, bodies of perfected shape will always do; but Juno's eccentric orbit proves her to be of malformation, so that as new matter becomes added her shape changes, and in the same degree the figure and leaning of her orbit. The operations no doubt are going on at a rate wonderfully slow, or creation in the chaotic state over this comparatively near division of the system would not have so long continued; but the work goes on and must do so while the sun rotates, and whatever matter stumbles into her, be it ever so little, must by so much change her shape and lines of motion. These changes will thus gradually mould her path into the tracks of other asteroids, which so far, by being out of her line or lines of motion, have escaped incorporation since they were formed as planetoids out of the mass. A large proportion of the planetoids—or, we should rather say in their present enlarged condition, asteroids—are already incorporated into her as the future primary, or else she would not be by comparison so large; but the supply is still numerically abundant, and they eventually through the operations going on cannot escape for ever, but must all in the remote future be incorporated into this one body as their parent planet. They are still free, because by the leaning of her orbit she moves clear of their courses; but as observed above, change of shape not only in Juno but in the asteroids themselves—both causes combine—will gradually modify their inclinations, so as in the end to bring them into such relationship that they will in due time be liable to be caught as they one after another are led by their motions on her fatal track. It is thus easy to see—as the work continues without ceasing—that the multitudinous number of little worlds which intersect the path of this small planet must by the power of its attractive sphere—a power by the growing magnitude of the body expanding wider—in time all drop into it.

From the eccentricity of the asteroidal orbits in general and their number, it cannot be otherwise but that, practically speaking, all their orbits, including those of the planetoids, cross in common and intersect the orbit of Juno; but they must have other relations besides, before they can be finally incorporated. Those which describe their orbits on or nearly on the same plane, if they intersect her orbit, whatever may be their mean distance when their times of close conjunction with the planet come, must succumb; likewise many others, although their orbits may lean for their safety sufficiently out of a common plane, it is also their fate when coming up with the planet at their nearest points to be incorporated. If discovery could only descend into such minutiæ it would very likely be found that there are at present very few if any of the asteroids which bear the above relations to the parent planet, for most all so related have no doubt in the past been incorporated. It is likely to such that Juno is indebted for the degree of magnitude she has already attained, but it by no means follows that the asteroids otherwise related will forever escape; yet, judging from their present relations to Juno, their respite generally must be long. They would remain safe and separate forever, so far as she is concerned, if their orbits would continue without change. But orbits take their figures and inclinations from the shapes of the bodies which describe them; so amongst such small bodies, as they change in shape their orbits in the same degree change, both in inclination and figure. The little planetoid previously collapsed together in any chance shape, just according to the irregular conformation its at-matter previously took when it was a gravitating aerolite. Thus its orbit in conformity to its shape may be eccentric to any degree, and equally inclined from the planetic plane. It can only continue extremely so until either through its movement it becomes enlarged by the reception of smaller portions of matter, or itself falls upon and enlarges another. If it is itself enlarged by the incorporation of aerolites, or otherwise, it runs on another orbit in conformity to its change of shape, and as such changes in small bodies are always liable to happen, they alter the figures and inclinations of their orbits so repeatedly that wherever they are, or however related, they are all sure at one time or other to be laid hold of and incorporated by the greater bodies nearest them whose orbits they trespass over.

However, every change the planetoid undergoes by the addition of matter—while it by so much affects the relation of its orbit to the planetic plane—has the effect in nearly all instances of bestowing upon it a more perfect shape; but, as before observed, bodies can rarely or ever reach perfection of shape until they attain considerable magnitude. In the existing order of things, once they rise up to be of perfect mould, no accession of matter can ever in any sensible degree alter it, but circumstances so combine that some bodies will have to reach much greater magnitude than others before advancing to perfection of symmetry. Take, for example, the planet we are reasoning upon, Juno—the one we suppose is very slowly advancing to the proud position of a ninth primary—her orbit is twice as long as it is broad, and the sun's position within it is two hundred and fifty million miles from the one end, while he is less than half that distance from the other. It must therefore be an elongated imperfect formation of the planet which gives so great an eccentricity to its orbit,* a defect which will gradually disappear as during the lapse of time the body enlarges. A small body cannot be otherwise than irregular in shape, a larger one less so, until we reach a certain magnitude higher or lower according to the primal operations which first began to enlarge it; but once of perfect shape, it is likely to continue so forever, run on the same orbital figure without variation, and with an inclination to the planetic plane unchangeable, just the same as the primary planets of the system are known to do. The actual operations at work demonstrate why it is that bodies after attaining the perfection of shape cannot afterwards become altered in figure, and that their final or permanent shapes can be no other than round or spheroid, the latter shape being always more or less on a body according to its quickness of rotation. If there was any body without rotation, when once it rose to its perfect shape it would be a sphere; but with this motion, which we suppose is common to all bodies, its perfection of shape would be more or less spheroidal as to the rapidity of its rotation.

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* We would naturally look for a body so large as Juno to be almost of perfect mould, but the difficulty of its malformation may be met by considering her exceptional position. The other planets, for instance, collected in the planetoidal formations which made up their nuclei at a much earlier time, while they—the planetoids—were yet by comparison small. Juno in her present condition is not unlike what the others were in the past, surrounded with small bodies which are destined to be in time part of herself; but there is this difference, they are ancient overgrown planetoids, swelled up by time into little worlds in themselves, and so long as she continues to incorporate such large collections of material at a time she must of necessity be of irregular shape.

That the principle may be illustrated more clearly, let us take the earth as one example—a body which no doubt has long reached perfect configuration; but very likely an immensity of time after it was a planetoid. Every addition from its lowest step of independence it subsequently received, naturally imparted to it rounder outlines up to the time when it had increased to a respectable magnitude, after which the increments by comparison became insignificant as they continued and do still continue to fall in on an equal average over all its surface. Thus as it constantly grew out, it became more and more of a perfect form, yet it could not have attained perfection itself before being clothed with an atmosphere. The shower of snow, for instance, on a calm day may not deposit over the ground a layer in depth, however near it may be, of perfect exactness; and in the shower of matter which has been falling from the beginning upon the earth, while it on the average must settle down in about equal proportion over all the surface of the globe like the shower of snow, there may not be the equality of mathematical nicety, but the corroding atmosphere and running streams are constantly levelling the higher prominences and filling up the depressions. Thus the face of our globe is kept, it may be said, in its polished perfection of shape—its hills and hollows in comparison to the whole are as nothing.

The roundness of the earth in common with other bodies can thus be clearly accounted for, simply because it is always in the midst of a shower of matter, seen and unseen, however wide apart the drops may be which descend, on an average extending back for millions of years in equal proportion on its surface round the entire orb, causing it to grow evenly out alike; and should the quantity in any given position exceed mathematical nicety, the atmosphere and running waters keep the balance even. Our world therefore, as well as many others, continues in shape all perfection—not a sphere, as a body without rotation would assume, but with its equator a true circle, and in the lateral directions a falling off up to the poles, the causes of which may be thus explained: The earth rotates at a certain rate, and if a stone is thrown, this motion of the earth leads it along while it is up instead of leaving it behind. In other words, the stone while it is up accompanying the earth's motion is in reality revolving motion on the lowest scale, for it is on the same principles the moon revolves round the earth and the planets round the sun. Rotatory motion has also the further effect of inclining the bodies up in the direction of the equatorial plane of the body which governs, whether it may be the sun in connection with the planets, or the moon under the rotatory guidance of the earth. The same force which inclines the planets and moons up to the equatorial planes of the bodies which rule over them, actually affects the thrown stone. It not only revolves while it is up, but through the same influence is inclined more or less in an equatorial direction. The distance it is inclined equatorially during the short time it is up must be so infinitesimal as to be below the nicest observation, but whatever it may be, in that direction it cannot but be inclined a something. In like manner, the matter which is constantly descending upon the earth from without, whether it may be atoms, aerolites, or planetoids, is similarly acted upon, but on account of long descent in a proportionately greater measure. During the time of their fall, after stumbling into our surrounding attractive sphere, they begin to revolve in obedience to the rotation of the earth, and thus in falling to it are inclined some distance, however short, in the direction of the equator; and as all the objects of matter which have come down upon the earth since the beginning have been influenced in like manner—in short, the total in its descent being led somewhat in the direction of the equator—it follows from these operations that the entire globe up towards the poles on either hand must necessarily decline by so much from perfect rotundity.

The falling away in polar direction, or rather the spheroidal shape of any body from the above causes, must be according to the rapidity of its axial motion. Three of the minor planets as a curious coincident differ little in their rotatory motions, hence if they are all bodies developed into perfect shape, they should as spheroids be about the same, and subject to the hypothesis that bodies describe orbits in accordance with their shapes, their orbits must be of nearly equal eccentricity,* and with about the same inclinations to the planetic plane.† Again, the major planets, Jupiter and Saturn, turn once on their axes nearly two and a half times as fast as the minor planets, and we know this much of them that they are flattened in polar direction to a greater degree, although it cannot be accurately ascertained whether the declension is exactly according to their more rapid rotations. Finally, the sun and moon should be nearly perfect spheres, on account of their very sluggish axial motions. As regards the sun the rule holds good, for he is so nearly spherical that we have yet to hear of any declension from the sphere being perceptible in his shape; while, on the other hand, if we were to judge of the shape of the moon by the figure of her orbit, we must conclude that she is far from perfect as a sphere. To look at her she is perfectly spherical, but the appearance may be deceptive to the extent of the measure of eccentricity in her orbit; besides, from her smallness, she may not yet be moulded into the perfect shape natural to her as a body. Her shape also is likely to be somewhat affected from the want of an atmosphere, which has done so much for the earth in smoothing down its outlines. At all events, whatever the true shape of the moon may be, in regard to being all but spherical, the principle still holds on the clearest evidence that the spheroidal shapes of all bodies are imposed upon them by their rotations, and being otherwise globular proceeds from the fall of matter upon them on all sides and from every point in equal proportion. That their orbits are figures conforming to their shapes we cannot speak upon with the same confidence, so we must leave what cannot be established by indisputable facts an open question, while we have little doubt of its truth.

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* The movement of Mars on its orbit deviates widely from the above rules, but if the figure of its body was nicely observed it might be discovered to be of malformation, which would fully account for the eccentricity of its motion.

† The planetic plane, it should be remembered, is not the plane of the terrestrial orbit, but that plane which coincides with the equatorial line of the sun, which we think except by calculation would be very difficult to mark down with accuracy.

With the foregoing remarks on the causes which give rotundity to bodies we are now better prepared to return to the subject of the planet Juno, by in the outset observing that at her perihelion position round the sun she encroaches about twenty million miles within the orbit of Mars. It thus follows that if the two orbits were nearly on the same plane, as a body she would long since have been incorporated with Mars, or else, if endowed with slower rotation, linked to it as a moon. Their orbits being considerably inclined from each other have prevented either event from taking place, and thus far the independence of the smaller one is safe. The danger, we suppose, will at some time be overcome by the enlargement of Juno. By every addition, according to the nature of things, she is likely, we might say almost certain, to become more globular and move on an orbit more circular in accordance with change of shape, which will in time disenthral her from her dangerous relations with the above planet. In other words, as she by additions becomes more perfect in form like the other primaries, she will move on an orbit more circular, with the sun in the same degree nearer its centre, which will reduce her whole course from trespassing either on the limits of Mars on the one hand or Jupiter on the other. Without such a free course it is impossible that she or any other body could remain permanently independent.

A more circular orbit would extricate Juno from her dangerous connection with Mars, for the obvious reason that her course trespasses only a short way within the orbit of the latter; but in regard to most other small bodies that cross over the orbits of larger planets, as they in nearly all cases move deeper within their precincts, no orbital changes of shape could in the future liberate them from their toils. The smaller, when they intersect, must therefore be inevitably incorporated with the larger some time or other, except that in extremely rare cases they may be preserved as moons.

The gradual change of shape which time effects is one of the real causes for the eventual mutual incorporation of all bodies which thus cross over each other's paths. Nature at first imposes malformation upon them, and for a time many of them lean free from peril, but with every addition of matter they have change of shape which shifts them step by step nearer danger, and thus by these operations they in the end become part of one or other of the very few bodies creative operations permit to be permanent. And we may once more repeat that these latter, the primaries, owe their safety to the unassailable positions of their respective orbits. They are bodies of perfect shape and almost uniform, so they move nearly on a common plane. Thus related, if any one of them intersected another, the smaller of the two, except there was a very near equality of magnitude, could not escape being incorporated by the larger, or else a somewhat better fate, its subjection to it as a moon. The subject viewed in this its true light, especially when we consider the great eccentricity of immature or imperfectly formed bodies, gives the clearest possible evidence that there can be no room for more primary planets in the system than the few, including Juno, which actually exist. For that planet to gain such independent relationship—a course free from any one of the other primaries—she will have to pass through the ordeal, which to a world not possessed of living beings * is not serious, of being fallen upon by a great number of little worlds swollen up during the lapse of time far above their primal magnitude as planetoids. Instead of Juno being lost in them, they will all in succession be lost and swallowed up by her as the greater.

A general idea prevails that two worlds thus darting into each other, one say a thousand and the other a hundred miles in diameter—something like the comparative difference in magnitude betwixt Juno and the largest known asteroids, all of which bodies we suppose are destined during the lapse of time, may be millions of years, to fall into her—would by the concussion dash the fragments of both bodies far and wide into space, just such another concussion as scientific men at present conclude gave rise to all the meteorites which have dropped down upon the earth from time immemorial. They reason in this wise : two cannon-balls moving at full speed, should they hit each other, would be in themselves, however small, a powerful shock, hence they conclude

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* Why we pronounce this little planet bare of life, is that we suppose it to be impossible such an insignificant body, vastly smaller than our globe, can have an atmosphere which would support life. It may and most likely has passed through a comet or comets repeatedly, for we must bear in mind that as a body she is older than the major planets themselves. Still, admitting these probable facts when passing through a comet, in any of her transits through them she could only hold fast its atmospheric material as to the strength of her attraction. The very little quantity of atmosphere secured by the feeble attraction of a body so small would be without the requisite density to generate heat that would produce water, without which it is unnecessary to say there could be no *life*.

the collision of two worlds would be in the same degree more powerful as they are larger and their motions swifter. If these conditions betwixt two colliding worlds of the above magnitude held good, there is not the least doubt—although a wide disparity in their magnitude—the debris of both would be widely spread into an ocean of dust, perhaps never again to reunite. Worlds however, as we have so often observed, never can come together with motive force—there cannot be motive force in the movements of celestial bodies—at least the larger of the two; with regard to the smaller, if it has at the last moment momentum of motion, the force wholly proceeds from the larger when sufficiently near by its attraction to impose gravitation in its own direction on its materials. The smaller body then descends, not as a solid—it is impossible when collisions betwixt independent bodies take place that the smaller can hit the larger solid—but as an immense quantity of looseness, which in the aggregate, when the colliding body is of considerable magnitude, must impart a deadly shock to the larger, but is yet powerless to break it up or materially alter its features except by enlargement. As a contrast, the cannon-balls are both according to their magnitude heavy gravitating objects—caused by a third immensely greater force—and just in the same degree as they are heavy and their motions rapid, the force of their concussion is greater. The two worlds previous to collision have no weight, so they cannot have motive force; the cannon-balls are both heavy, and just in the same degree are their motive forces and their concussions more powerful. All objects on the surface of the earth are heavy, and when put in motion must have force; in their motions all the heavenly bodies are without a grain of weight, light as shadow or spirit, and are led about by rotation, the motion which rules the universe, and while they retain these vital attributes of independence, if they were even led into collision by their motions, they would come harmlessly upon each other, without making an impression that could be felt or even disturbing a grain of sand.

It is only by the crossing of orbits that any bodies can come together, and the two we are considering had these relations, we presume, through the long ages which have passed since our field of mist disappeared into the sun. The many changes undergone during all that time at last so altered the inclinations of their orbits that at or near the intersections, when both at the same time happened to be in one of these positions, they were liable to unite. The event of course would only take place when both were in conjunction with the sun, and only an exceptional one when the two were sufficiently near one of the intersections. Once the smaller one is deep enough within the attractive sphere of the larger, then follows—what will in time take place betwixt all the asteroids and Juno—a collision. Immediately before taking place, both are moving in conjunction with the sun from west to east—as all bodies in obedience to the central rotation which governs them must do—when they very soon approach the point of intersection sufficiently close for the smaller to be within governing distance, or rather under the merciless power of the larger. In any case, when the axial motion of the smaller is slower—and it must be considerably so—it has a chance of being spared as a satellite to the larger, but if not, its inevitable fate is incorporation.

Such collisions never take place, at least not one time out of millions, by the one hitting the other straight on—that is, coming into contact after the manner of the two projected objects referred to meeting, but simply by the smaller stumbling within the attractive sphere of the larger. When thus caught within secondary toils, out of them neither it nor any body can ever escape; for there is some unknown law yet to be discovered, that when a body is once led by its motions within the fatal precincts of secondary rule, it can never escape out. It continues when once ensnared to descend nearer to the body in the centre, just to that point, if it be large enough to be its satellite, where it will describe its orbit round its new governing body, and turn once on its axis in exactly the same time; when its rotation is sufficiently slow it may continue as its moon, but otherwise nothing can save it from becoming part of the planet. It is the latter catastrophe we are considering. In descending, after getting ensnared within the planet's predominant attraction, as regards gravitation the captivated body is still independent—for a body of a hundred miles in diameter must come very close to another, although ten times the same diameter, before it loses its attractive centre—but being caught within the deadly grasp of secondary rule, it must continue descending to its doom. As it approaches, the bond which holds its own materials together becomes weaker as it gets nearer, till at last the heart and life, as it were, is taken out of it. Not an atom of the mighty mass inclines any longer to its own native centre, for the destroying body acts with a stronger attraction on all its parts. Gravitation or weight is imparted to them in that new direction, and thus the whole body, loosened in all its parts, pours out all its incoherent and passive materials to add still greater magnitude to the larger body incorporating them.

Such is the true condition in which any smaller body becomes incorporated with a larger, whether it may be an aerolite, planetoid, or asteroid; for we again repeat that no one celestial body can be incorporated into another, except there is a measure of difference betwixt them that will endow the larger with attraction sufficiently powerful to rob the smaller of its attractive centre at or immediately before coming into contact. If the larger had no such predominant power, or rather if they were nearly equal in magnitude, a collision could not happen except their previous motions would lead them straight on each other. This not being impossible to intersecting bodies, they would simply collide and stumble past each other without the least shock being given; for things with-but weight, which in reality is an absence of gravitation, with whatever velocity they move, having no motive force, cannot injure each other. Nor is it in any one sense necessary to dwell longer on the question, as such relations betwixt bodies nearly equal in magnitude are unknown, and there would be no such equality betwixt the asteroids and Juno as they in succession become incorporated with her. The difference betwixt even the largest one of these small bodies and the planet is so great, that whenever it may be caught all its materials will have gravitation imposed upon them from their native centre towards the new one, at least immediately previous to contact, and when it takes place the force of the collision will be equal to the new weight imposed by the planet's attraction and the velocity of approach. As we suppose the descending motion previous to contact is with meteoric velocity, so far as the motion is concerned the colliding force—notwithstanding that the materials are poured in loose—must be tremendous. But to properly judge the operation there is another factor in the force, and indeed the main one,—the weight of the materials at the moment of contact. They must be light or heavy according to the magnitude of the body fallen upon. Any one of these asteroids—take for example what we suppose to be the largest, a hundred miles or more in diameter—falling upon the earth, the loose materials would have terrestrial weight imposed upon them, and the convulsive shock be in an equal degree powerful; whereas the same asteroid coming down upon Juno, a planet by comparison so insignificant, its materials poured over her surface might not be heavier than common sawdust on the earth, and thus the shock would be such as light materials of the kind would impart, but still invested with great power through the velocity of approach. It may also be observed that as these asteroids fall in, they will not come as solid rocks, for no operations have been at work in bodies so small as to produce such hard formations. True, if to compare with, we were to reason from the earth on such a question, we would find its crust nearly altogether composed of hard rocks of great variety, many of them what geologists call primary, but secondary rocks in much greater proportion at least on the surface, and we suppose the same holds good down to the deepest stratum formed by the first atmosphere. No such formations can belong to the asteroids, for on such bodies there could not have been the same operations to produce them.

Thus, in the first place, what we term our secondary rocks we suppose are entirely due to the atomic matter constantly coming in to us from without, which by the agency of the sea becomes calcareous or schistose formations,* or nature uses it as a cement to bind the grains of sand or rubble washed from the land into freestone or conglomerate. We again suppose that the primary rocks are made to crop out when pent-up gases at rare intervals—may be on the average once in a period of no less than a hundred thousand years—crack the outer crust, and thus, like albumen from the cracked shell of an egg, the interior melted liquid protrudes at various points and hardens down into our granite ranges. The petty asteroid has none of the above attributes, whereby rock of any description could be formed. It will be admitted that all its materials were first received into it in the primal state without previous change, and to a certain extent in so small a body they still remain unchanged, as there could have been no internal heat to reduce them to a liquid state so as to give birth to congealed rocks. And as regards secondary rocks there can be none on the asteroid, for it is without water or a sign of moisture for want of atmosphere, and without water we need scarcely say secondary rocks could not be formed. As to pressure, from which geologists are so fond of accounting for the solidity of secondary formations, we here deny that the petrified condition we find them could ever have been caused by such agency. Still, if we admit that pressure may have had something to do with the cohesive hardness of our secondary formations, the principle does not apply to the lowly asteroid. Its pressure can only be as to its attraction, and this force belonging to it, compared to that of the earth, must be almost infinitesimal. The largest existing known asteroids—excluding Juno and Vesta from the list—are in magnitude each only about a millionth part of the earth. The attraction therefore in these small bodies, if philosophers were on them for the purpose, except that their materials keep together, would be almost beyond their detection, so the pressure must be in the same degree feeble. Yet as the asteroid has attraction, however low it may be, causing by this force all its materials to cling towards its centre, the superincumbent materials thus pressing the lower down must be a strong pressive power deep in the body; but still the pressure—if it was possible that pressure simply in itself could harden loose material into rock—taking any view of it, would not be great enough for the purpose. In short, we must look upon the asteroid as truly primal. It has not an atom of moisture, for it has no atmosphere, and its aqueous matter is still unmelted, all its materials are purely dry, and without any alteration from their primal state. There is not even a grain of sand in their composition, but the whole no doubt compressed to a certain degree by the combined attraction of all the parts, and whatever may be the conditions or appearances produced upon them by this force, it must evidently be too weak if pressure, however powerful, could have the effect of compressing matter into the petrified hardness of rock.

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* We are indebted to the deep-sea discoveries for our ideas on schistose formation.

The foregoing observations prepare us to look upon any one asteroid falling upon Juno—and the reasoning equally applied to all the primaries when they were rising into magnitude during their several chaotic periods—as a composition of primal atomic materials never heretofore changed into rock, and in a certain sense without any change whatever. When once caught and charmed into the right distance it loses its attractive centre, then its whole materials instantaneously become disunited, and in this loose condition are poured on the planet with such a weight as the attraction of so small a body as Juno can impose upon them, together with the velocity of their approach. We may therefore look on the shocks, which Juno in the course of time receives from the many asteroids which are destined to raise her up to the rank of a primary, will not in themselves be sufficiently powerful to seriously affect her structure as a body, or even at the times of collision to spread the materials outwards, as they would be too light on the surface of so small a body to have projective force sufficient for the purpose. There will be one effect produced: her shape in the nature of things will become more globular as her magnitude gradually increases by the incorporation of these asteroids, which by nature will all in time become part of herself. True it is, the reception of such additions in the past—judging from the figure of her orbit—have given to her an irregularity of shape, but whatever effect coinciding circumstances may have had, these operations as they continue will undoubtedly improve her figure into a more rounded form, yet perfection of shape will be impossible while she is the recipient of such large additions at a time. The other eight planets during the chaotic periods of their formations were no doubt in like manner—but in a less degree—irregular in shape; but after they had had time to draw into themselves in their several positions the planetoids formed out of the mist, many million years must have since passed away, and through all that time up to the present the shower of unseen atoms, aerolites, and planetoids have been constantly descending in equal proportion all over their respective surfaces. These operations, together with the action of their atmospheres, which we suppose they all possess, have imparted to the earth and likely to most all the others perfect shapes. In regard to Juno, the ninth one, these changes have yet to take place, for the early materials which set up the others are only yet half collected into her, and when the time comes that they will be all incorporated, which may yet take up millions of years, it will require an immense period still deeper into the future to mould her—if she ever attains it—into that perfection of figure which we suppose generally belongs to the other eight.

When the time comes that chaos will be at an end in the asteroidal zone, and when no two of the small bodies which are visible within it will intersect each other's paths, or in other words, that their separate existence will have ceased by their universal incorporation into Juno, what figure, we may ask, will she cut as one of the nine? Our unhesitating reply is that it will be a very low one, perhaps not exceeding half the size of our moon. Notwithstanding, she will hold high rank with the others, and were it not that her relations to Mars are precarious, she should now be placed on the lowest step as one of the number.

It may, however, be considered that her status will not be so very low when above a thousand visible asteroids, known and unknown, besides as we suppose the lower and more numerous invisibles, all become added to her. Yet when we take into account by calculation the great number of small bodies, such as these asteroids, it takes to make up a large one, we very soon discover that if they were ten thousand in number, instead of the few by comparison which are known, the whole added to Juno, although as a celestial body very small in herself, would not in a very sensible degree increase her magnitude.* In short, when chaos in that latitude is at an end, and all the materials which nature has provided for the first step of magnitude in the building up of that planet are collected into her, in greatness even as a lunar body her rank would be rather low, and very considerably smaller than our moon.

In the prospect of Juno being so small a planet, a curious anomaly presents itself in this part of the system, upon which we have offered a few observations previously—namely, How is it that matter thus far in this direction seems to lessen while space spherically expands wider? The materials of all the planets, for instance, are derived from two sources, aerolites, including invisible matter, and planetoids, and so far as the former are concerned, if no planetoids were formed we would naturally look to succeeding bodies getting larger in the various steps receding from the sun. This rule holds good with the first two planets, Mercury and Venus, but the earth, instead of being greatly larger than the latter, no two of the minor planets are of nearer equality in magnitude. Mars, again, from its position should be at least four times as large as the earth, whereas it is only a fifth part of its magnitude. Lastly, we should expect matter in the asteroidal zone—although a large proportion of it is still in the chaotic state—to greatly exceed the planet Mars, even if of the natural magnitude it should be from its position, instead of which the whole if centred in one body would be insignificant. We thus see in taking the minor primaries in succession that the two nearest the sun are of the natural size according to their positions, but in the earth there is a very considerable falling off, while Mars has not a tenth, or Juno, including the asteroids, a hundredth part of the matter which naturally should fall to their shares in the positions they hold.

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* There are about 170 of the asteroids already made known, and at the rate their discovery is progressing the number on the celestial map will soon reach a round 200; but they are too small for their magnitudes to be known. Vesta, however, which is looked upon as the largest, is considered to have a total surface of no greater measurement than the whole of France, and roughly calculating, this would admit it to be a body of about 200 miles in diameter. Now, if we take Juno to be also in diameter 1400 miles, compared with each other she is 273 times greater in magnitude than Vesta, the largest known asteroid. But it must strike any one seriously reflecting on the subject, that the great majority must be vastly smaller than the above-named asteroid, and that the leading ones might not average so high as a hundred miles in diameter, and some of the lowest and most numerous may not even exceed twenty miles —that is, if bodies so small could be visible to the telescope at such a distance. Everything considered, we might put down the average magnitude of all the discovered asteroids as not exceeding 50 miles in diameter. On this assumption, we find by calculation that if all these bodies, known and unknown, numbered ten thousand, and were incorporated with Juno, they would fall short of doubling her magnitude. In presence of the great difficulty which observers have in detecting these specks, the asteroids, among the millions of telescopic stars in the background with which they are in common confounded, it is astonishing they have succeeded in bringing so many to light. The feat must be looked upon as very creditable to the perseverance of modern scientists, but their great achievements tell us unmistakably that if there were no telescopic stars visible behind, so that the asteroids large enough to be discerned by the telescope would only appear, they could be counted over that chaotic belt of the system perhaps in thousands. Yet, even after taking this extreme analogical view of the supposed vast number, if they were all incorporated with Juno—and whatever the number may be, that work will assuredly continue while one orbit continues to intersect another—taken altogether they would not greatly increase by comparison her magnitude as a body.

Jupiter, in the near distance beyond, fully accounts for all these anomalies. By his sweeping influence as a secondary body he has robbed the earth of much, Mars of more, and Juno of most. The nearer he is, his power over the planetoids hanging in their respective latitudes progressively increases, not by his attraction—a force no doubt indispensable in all celestial operations, but in planetary formation it only plays a subordinate part. The real power of a secondary body in drawing smaller bodies into itself consists in its sphere of attraction sweeping round its circular course, in drawing in all smaller bodies from atoms upwards which stumble by their movements within the expanse of its predominant attraction. When once within this area, if not satellised, they must become incorporated with it, and the wider its attractive sphere is, its power of incorporating smaller creations is in exactly the same degree greater. It is therefore by the wide sphere of attraction, and the comparatively insignificant areas the other adjacent planets rule over, which renders Jupiter all-powerful in depriving them of a vast proportion of creation which otherwise naturally belongs to their positions in the system, and not to the gravitation of aerolites, which all share alike according to the expanses of their attractive spheres.

That the power of Jupiter over the adjacent latitudes nearest him in the system may be made clearer, let us observe that the instant an aerolite by increase is raised to the condition of a planetoid by its attraction turning to its own centre, its whole matter presses into whatever shape it may be. As the shape cannot be globular, the orbit it at first runs upon is in the same degree eccentric, as it in its shape differs from roundness. Just according to the degree of its eccentricity the position of the sun is nearer the one end of the figure it describes, and it is important to bear in mind it is this relation to the sun—a law which universally applies—that indirectly invests Jupiter with such commanding power in drawing in nearly all new secondary formations for hundreds of millions of miles on either hand, and thus far crippling the growth of the primaries which lie nearest. His sweeping influence in clearing adjacent space is caused by his wide attractive sphere. The power rests in the attractive sphere itself, but the cause lies in the eccentricity of the planetoidal orbits, which we suppose vary in this respect more or less according to the shapes of the planetoids that describe them. Some planetoids—although not one can be round—may happen to be of such a compact shape as to run on orbits in the same degree less eccentric, so these odd planetoids, perhaps one in a thousand, do not apply; but all other planetoids run on figures eccentric more or less, according to their configuration, with the sun in relation to them all, in the same degree nearer one end of their respective orbits as they as bodies deviate in shape from rotundity. It thus follows that these invisible bodies which have their perihelions in the terrestrial latitude, will, from their varying eccentricity, have their aphelions generally as far out as Juno, Jupiter, or Saturn, or in rare cases so eccentric—all depending upon their conformation — that like comets there is no room for their orbits; their wayward motions lead them into adjoining systems, never to return. As therefore all such insignificant bodies, with few exceptions, have eccentricity which leads them out as far as Jupiter's track and beyond, the inference is easily arrived at, how it is the great planet has been enabled, by its wide-extended absorbing attractive sphere sweeping round the heavens, to hold fast every object of matter which moves within it, and thus to bare the region from the earth to Juno of such a large proportion of matter, which otherwise would have belonged to it.

Every planet, be it remembered, lays hold of matter in exact proportion to the measured disc of its attractive sphere, and taking into account the broad expanse of Jupiter's rule compared to the comparative insignificancy of the attractive spheres of the minor planets, and that planetoids from their nature, except it may be one case in hundreds, must cross and recross these primary orbits in common, they have all as great a chance of being laid hold of by Jupiter as opposed to the other planets as his attraction predominates wider. This it is which clears up the mystery of the gradual falling off of matter, beginning with the earth—the declension at every step increasing up to the precincts of Jupiter, the great and only cause. To us the loss is great gain, for had the earth been very much larger—as it undoubtedly would have been, if it according to its position had received its natural share of matter—the stronger attraction would have made us to ourselves more cumbersome, locomotion more difficult, and, according to the much greater weight of all materials, labour more oppressive.

The attractive spheres of secondary bodies, wherever they may be, must be looked upon as so many nets to either lay hold of matter falling to the sun, or the planetoids which by their orbital motions stumble into their meshes. Just according to the wideness of the nets is the measure of new creation which falls to the share of each body respectively; and once matter in any condition is within the toils of these fatal nets or attractive spheres, even if collected into worlds, it can never escape out—its separate existence is lost, and it must become part of its destroyer, except in the rare instance of odd ones being spared as moons, or still rarer cases of large worlds by the same operations on a gigantic scale being changed by the mighty forces of their collisions into annular bodies. Moons, however, and worlds which were destined to be metamorphosed into rings, must have been bodies formed out of our Galaxy as planetoids, coeval with the planets to which they are attached. As therefore in the present settled order of the system planetoids seldom rise higher, it can only be such small bodies and their capture which we have to consider, and the proportion laid hold of by Jupiter compared to the share the small adjacent planets receive may be better understood by the following calculation. Planetoids, which from their eccentricity—and we suppose the movements of nearly all this lowest class of bodies are sufficiently eccentric for the purpose—cut the orbits of both the earth and Jupiter, as the attractive spheres of both planets act as nets to lay hold and keep fast all bodies or objects which move into them, if these attractive spheres were of equal expanse each of the planets would on an average receive about equal; but Jupiter rules over a wider space, and the proportion which falls to his share is in the same degree greater. If we knew accurately the disc measurement of their respective spheres of attraction, we could tell almost to a nicety the proportion each receives, but that important item of knowledge is denied us. We think, however,—as we know something not very far from the truth as regards the earth,—we will be taking a very moderate view of the question by putting down the attractive sphere of the latter at three-quarters of a million miles, and that of Jupiter at fifty million miles in diameter. On this assumption the breadth of the one sphere of rule divided into the other, brings out the astounding answer, that the disc measurement of the attractive sphere of Jupiter is at least three thousand times greater in expanse than that of the earth. Taking the above as correct, it follows that all the planetoids mutually related to both the earth and Jupiter—so that they in time must be incorporated into the one or other—out of every three thousand the earth has only the chance of receiving a solitary one. All the others fall to the share of Jupiter, except units, which may also fall upon Mars or Juno, or a few that stretch their orbits out as far as Saturn, and thus get ensnared within its attractive sphere. We thus have in the existence of the great planet Jupiter at some four hundred million miles from us, the true solution of the increasing declension of matter from the earth up to his borders. He has, from the immense sweeping influence he possesses through his revolving motion, bearing round with him, in his circuitous course, his great attractive sphere, drawn in or rather captivated from the lower latitudes referred to, at least nine-tenths of the matter which would actually be attached to their primaries had no great planet been there. Of the whole space thus stripped of its natural share of matter, the belt on which the asteroids revolve, on account of its nearest proximity, has suffered most. The breadth of this belt is just the space clear betwixt the nearest points at which the attractive spheres of Mars and Jupiter approach in passing round their orbits; and everything considered, it cannot be less than a hundred million miles, or a span which takes in a depth of a thirtieth part of the system. Yet, what do we find? A great number of very small bodies, visible for the most part only to the telescope, which, when all are collected into one body, will not exceed half the size of our moon. These hundreds of asteroids, we might analogically say thousands, which lie still scattered, we look upon as the primal planetoids which were left behind when the atomic Galaxy first centred into the sun, but increased up to their existing magnitudes in very small measure by the descent of aerolites, or now and then through long ages by mutual incorporation; but they are only the miserable remnants left out of the multitude of the primal planetoids. Of the vast number which we suppose existed at that first step of secondary formation, there were sure to be some odd ones—not more than one in a hundred—that then, and since then, were so little eccentric as not to trespass on the perilous track of Jupiter. These are the few out of the many which are still left, and except the small proportion which have thus far added to the magnitude of Juno, all the rest, practically speaking the whole, have long since lost themselves in the devouring embraces of the great planet.

THE END.

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